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SPECIAL REPORT

ON THE

BEET-SUGAR INDUSTRY

IN THE

UNITED STATES.

MARCH 31, 1898.—Referred to the Committee on Agriculture and ordered to be printed.

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MESSAGE.

To the Congress:

I transmit herewith, for the information of the Congress, a communication from the Secretary of Agriculture, covering a detailed report showing the present condition of the beet-sugar industry in this country and the results of experiments made by the Department of Agriculture in the production of sugar from beets in the United States during the past year.

WILLIAM MCKINLEY.

EXECUTIVE MANSION,
March 31, 1898.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., March 25, 1898.

MR. PRESIDENT: In a communication which I addressed to the Vice President on the 17th of last January, in obedience to a resolution of the United States Senate, on the subject of sugar importation, production, etc., I made the following statement:

> Sugar will be grown in the United States by farmers. The Department of Agriculture has been experimenting in two-thirds of the States of the Union during the past year, and will experiment in all the States during the coming year, to ascertain where we can grow sugar-producing plants most profitably. A detailed report now being prepared for Congress will show the results of the work.

I now have the honor to transmit, for your information and that of the Congress of the United States, that portion of the detailed report above referred to covering the subject of beet sugar. For the convenience of its readers, I have divided it into two distinct parts, one part consisting of the report of the Chemist of this Department, Dr. H. W. Wiley, who for many years, and until the work was intermitted for a few years preceding my assumption of office, was in charge of the sugar-experiment work, which has formed the basis of most of the work undertaken by private enterprise in this important industry.

The second part consists of the report of the field agent, Mr. Charles F. Saylor, appointed May 10, 1897, who has personally visited during the past season every State and locality mentioned in his report, inspecting sugar-beet plantations and beet-sugar factories and interviewing the practical growers and manufacturers.

During the past five years the people of the United States have paid to foreign producers over half a billion dollars for imported sugar. The total domestic product for 1897 was 335,656 tons, the total refined product of beet sugar 1,760,607 tons, making the total consumption for that year 2,096,263 tons.

Of the total consumption of sugar in the United States in 1897, 45 per cent was beet sugar. As the production of beet sugar in the United States in 1897 was barely 12½ per cent of the total domestic product, it follows that the percentage of beet sugar imported last year to the entire sugar imports must have been considerably over 45.

Inasmuch as the total amount of sugar now imported into the United States can be produced upon a million acres devoted to sugar crops, it is manifestly of the first importance that the selection of localities for the production of sugar beets should be most carefully and judiciously made, and to do this requires that the sections of the country best adapted to the growth of this valuable crop should be definitely determined. This determination I conceive to be a duty clearly devolving upon this Department.

The facts and figures as briefly presented to your attention eminently justify, in my opinion, the devotion of time, money, and talents on the part of this Department to the development of this important industry. They also explain the widespread popular interest in this subject, expressions of which reach us on every side and from all quarters of the country. The demand for a farmers' bulletin on the subject of the sugar beet, prepared last year by the Chemist of the Department, both from Members of Congress for distribution to their constituents and from correspondents of the Department, has been such as to severely tax our limited appropriation for this class of publications. Nearly 150,000 copies of this bulletin have already been distributed, and the demand appears to be unabated. These facts, I believe, warrant the recommendation I have the honor to make in regard to this report, namely, that it be printed by the order of Congress in an edition sufficient to afford to this Department for its own distribution at least 20,000 copies, apart from the allotment which Congress may in its wisdom make for the use of its own Members. Another and very important reason exists for the printing of this report by Congress—that under the present law, without the special authorization of Congress, only 1,000 copies could be printed by this Department.

I have the honor to remain, Mr. President,

Very respectfully, JAMES WILSON,
Secretary.

The PRESIDENT,
Executive Mansion.

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H. W. WILEY.

LETTER OF SUBMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF CHEMISTRY,
Washington, D. C., March 2, 1898.

SIR: I submit herewith for your consideration the manuscript containing the data of recent investigations on the growth of sugar beets and the manufacture of sugar therefrom.

Respectfully,

H. W. WILEY,
Chief of Division of Chemistry.

Hon. JAMES WILSON,
Secretary of Agriculture.

PREFATORY NOTE.

The investigations conducted by the Department of Agriculture for many years in the study of sugar-producing plants and methods of manufacturing sugar in the United States were suspended by order of Secretary Morton in 1893. In resuming the study of this subject by order of Secretary Wilson, it is important that citations to the work already done be presented. The student of the subject will be able from these citations to have a general idea of the scope of the work which has been accomplished, and will be guided in further research by the data contained in the brief résumé which will be appended. It is not possible in such a list of citations to refer to the work which has been done by the agricultural experiment stations nor by private individuals. A collection of the titles of all accessible works in English relating to the subject of the sugar beet has been issued by the library of this Department as the library bulletin for June, 1897, entitled References to the Literature on the Sugar Beet, Exclusive of Works in Foreign Languages.

In the résumé of citations given below are first noted the publications which have been made in the annual reports of the Department of Agriculture, and afterwards a list of the special bulletins relating to beet sugar will be found. Many important papers have been published in the annual reports, which students of the beet-sugar industry might wish to consult. It is interesting to know that as early as 1867 Dr. Antisell, at that time the Chemist of the Department, pointed out the probability that an area or belt suited to the culture of the beet might be mapped out. He gave also some of the probable data which would be used in determining the limits of this belt. The annual report for 1868 contains a reference to the fact that Henry Clay visited Europe and made a study of the beet sugar industry on the Continent, and presented the results of his studies in a speech delivered in the Congress of the United States. Careful search of the records has not been able to discover this report in print.

It is to be regretted that many of the agricultural reports are entirely out of print, and the same is true of the greater part of the bulletins which have been issued on the subject of beet sugar. It will therefore not be possible for the Superintendent of Public Documents to supply the bulletins which are marked out of print to those who may desire to secure them.

Following the résumé of the work already done is given an account of the investigations conducted under the supervision of the Chemical Division of this Department during the year 1897.

REFERENCES IN ANNUAL REPORTS OF THE DEPARTMENT OF AGRICULTURE TO MATTERS RELATING TO THE SUGAR-BEET INDUSTRY.

1862. 536. Relative to the composition of beet juice.

1867. 32. Report of Thomas Antisell, Chemist, Department of Agriculture.

Dr. Antisell indicates the following as the probable "beet belt," based on temperature conditions:

"The northern limit of the beet culture is doubtful. On the plains of Russia it is grown where the isocheimal line is 10°. If this would hold good on this continent, there is no portion of the United States too cold for its culture. This vast extent of country is naturally divided into two regions, viz: (1) The middle division of the temperate zone of the United States, lying between parallels 39 and 43, comprising Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Ohio, Indiana, Illinois, Iowa, Nebraska, southern Idaho, with an area of 453,000 square miles, is favorable to beet culture, the mean annual temperature varying between 47° and 53° F; (2) the district between parallels 36° and 39°, embracing the border States, Delaware, Maryland, Virginia, West Virginia, Kentucky, Tennessee, Missouri, with Kansas, Colorado, Utah, Nevada, and northern California, possessing an area of 675,000 square miles and a mean annual temperature of 58° to 60° F., is also favorable to the beet; so that a belt of country 7° wide in latitude and with an extent of 1,129,000 square miles is open to this industrial art."

In experiments in beet culture on the Department grounds the maximum percentage of sugar in the juice is given for each variety:

Variety.	Number of tests.	Per cent of sugar.
White Silesian:		
Red top	12	6.97
Green top	10	7.20
White Magdeburg	12	7.74
Improved White Imperial	11	7.34
Beta Imperialis:		
No. 1	12	6.70
No. 2	12	7.40
Vilmorin's Improved	12	7.40
Castlenaudry Yellow	12	8.00

1867. 48. Methods of sugar manufacture in Europe.

1868. 158. Report of Theodore Gennert to the Commissioner of Agriculture. A general article on the statistics and manufacture of beet sugar.

1868. 164. Notes on the manufacture of beet sugar in Europe.

In 1867 the Department sent nine varieties of seed to Chatsworth, Ill., for trial, with the following results:

	Polarization.		Polarization.
No. 1	11.90	No. 7	11.98
2	10.95	8	13.67
3	12.59	9	13.25
4	12.21		
5	11.57	Average	12.40
6	13.52		

Mention is made in this article that while in Europe Henry Clay took much interest in the beet-sugar industry and afterwards, in a speech in Congress, predicted great results from the introduction of the industry into the United States.

1869. 334. A review of the manufacture of sugar in Europe.

1869. 345. A letter included in the above review. It reviews the manufacture in Europe and mentions trials made in the United States. The first attempt to produce beet sugar in this country, mentioned in this review, was by John Vaughn and James Ronaldson, Philadelphia. Seed was imported and beets were grown, but no factory was built.

1870. 98. Report of the Chemist on Beet Sugar. He states that the returns of the growth of sugar beets in this country have not yet shown an approach to that amount of sugar which is yielded by the growth of France and northern Germany. Beets grown at Chatsworth, Ill., from seeds supplied by the Department of Agriculture contained from 9.31 to 11.24 per cent of sugar.

1870. 215. Progress of the beet sugar industry in Europe. A brief statistical article.

1870. 210. Largely historical. Three establishments were in operation—Chatsworth, Ill., Alvarado, Cal., Sauk County, Wis. Capacity of the Chatsworth factory, 50 tons of beets per day.

1872. 154. Report of Ryland T. Brown, Chemist, United States Department of Agriculture. Following are some of the chief points mentioned:

The experiments of David L. Child, at Northampton, Mass., 1838, are probably the earliest recorded in this country.

The factory of Bonesteel and Otto, at Fond du Lac, Wis., 1867, had a capacity of 10 tons of beets per day; capital, $12,000.

Analyses of beets grown on the experimental farm of the University of Virginia, 1872, viz:

Variety.	Weight.	Sugar in the juice.
	Ounces.	*Per cent.*
White Silesian (French seed)	24¼	11.75
Carter's Prize Nursery (English seed)	16	13.72
Vilmorin's Improved (French seed)	30½	12.54
White sugar beet (Philadelphia)	33½	10.17

1872. 451. April, 1872, the legislature of New Jersey passed an act, operative for ten years, exempting beet-sugar factories from taxation.

1873. 108. A brief report by the Statistician.

The two California factories produced an estimated total of 750 tons of sugar during 1873.

1873. 287. Relative to the capacity and product of the Alvarado factory. Capacity, 7,000 tons of beets per annum.

1875. 512. A résumé of a German report on the composition of sugar beets.

1876. 153. Statistics of the production of sugar in various countries. Mention is made in this article of a factory at Soquel, Santa Cruz County, Cal. The State Agricultural Society of California reported in 1874 that the production of beet sugar in the State amounted in 1870 to 500,000 pounds; in 1871 to 800,000 pounds; in 1872 to 1,125,000 pounds, and in 1873 to 1,500,000 pounds.

1876. 266. Statistics of the yield of beet sugar, by countries.

1877. 243. A brief statement as to soils suitable for beets.

1877. 579. German statistics.

1878. 117. Analysis of a sample of beet-root sirup.

1879. 67. A report on the analysis of seven sugar beets received from various parts of the country. The percentage of sugar in the juice ranged from 8.9 to 14.3, the latter sample being from Oswego, N. Y.

1879. 184. General sugar statistics.

1880. 9. Report of the Commissioner of Agriculture. A report of the condition of the Maine Beet Sugar Company and a statement of the experiments in Delaware were made. Capacity of the Maine factory, 150 tons per day. In 1877 the State legislature of Delaware appropriated $300 as premiums to farmers for crops of sugar beets, and in 1878 $1,500 were appropriated for the same purpose. Imperfect experiments were made in 1878 by the Delaware Beet Sugar Company. The total crop amounted to 350 tons of roots, yielding an average of 9 per cent of sugar. A new factory was built by Colwell Brothers, of New York, costing $30,000, with a capacity of 60 tons of roots per day of twenty-four hours. The company did not make running expenses, but the experiment was encouraging.

1880. 619. A letter from E. H. Dyer urging a bounty law.

1881. 675. Statistics of sugar production. Statistics of domestic sugar are given in brief. Beet sugar was made successfully for three successive seasons in California in one factory. The Maine factory, which was in operation for three seasons, producing in one year 1,200,000 pounds and in another 1,000,000 pounds of sugar, was obliged to suspend operations for want of beets, which the farmers thought they could not grow at the prices offered, namely, $5 to $6 per ton.

1884. 22. Report of H. W. Wiley to the Commissioner of Agriculture on the Northern sugar industry in 1883. This is an abstract of data given in Bulletin No. 3 of the Division of Chemistry.

1884. 529. Yield of beet sugar in Russia.

1886. 341. Analyses of sugar beets grown in various parts of the country. Most of these samples contained very little sugar, with one exception. This sample contained 18.84 per cent, and was from Menominee, Mich. The highest percentage of sugar in the other samples was 11.71. Twenty-eight tests were made.

1889. 140. Cultivation of the sugar beet. Report of the Chemist.

1890. 167. Experiments with sugar beets. Abstract of a report published in full in Bulletin No. 27 of the Division of Chemistry.

1891. 150. Experiments with sugar beets. Abstract of a report published in full in Bulletin No. 30 of the Division of Chemistry.

1891. 156. Laws relating to taxation and bounties in various countries.

1892. 128. A résumé of experiments with sugar beets. Full details of this work are published in Bulletin No. 36 of the Division of Chemistry.

1892. 467. Statistics of beet-sugar production for the year 1892:

	Pounds.
Utah Beet Sugar Company	1,473,500
Alameda Sugar Company	2,506,860
Western Beet Sugar Company	11,390,921
Chino Valley Beet Sugar Company	7,903,541
Oxnard Beet Sugar Company	2,110,100
Norfolk Beet Sugar Company	1,698,400
Total	27,083,322

In 1891 these factories produced a total of 12,004,838 pounds.

1893. 175. Experiments with sugar beets. This is an abstract of a report published in full in Bulletin No. 39 of the Division of Chemistry.

1893. 184. Growth of beets at different altitudes.

LIST OF BULLETINS ISSUED BY THE DIVISION OF CHEMISTRY RELATING IN WHOLE OR IN PART TO SUGAR BEETS.

Bulletin No. 3, Division of Chemistry, Department of Agriculture. The Northern Sugar Industry; edited by H. W. Wiley, 1884; pp. 118 (out of print). Pages 24 to 29 of this report relate to the beet sugar industry.

Bulletin No. 5, Division of Chemistry, Department of Agriculture. The Sugar Industry of the United States; edited by H. W. Wiley, 1885; pp. 224 (out of print). Part second of this report, including pp. 73 to 136, inclusive, 12 plates, relates to the beet-sugar industry.

Bulletin No. 27, Division of Chemistry, Department of Agriculture. The Sugar Industry: Culture of the Sugar Beet, and Manufacture of Beet Sugar; edited by H. W. Wiley, 1890; pp. 262 (out of print).

Bulletin No. 30, Division of Chemistry, Department of Agriculture. Experiments with Sugar Beets in 1890; edited by H. W. Wiley, 1891; pp. 93 (out of print).

Bulletin No. 33, Division of Chemistry, Department of Agriculture. Experiments with Sugar Beets in 1891; edited by H. W. Wiley, 1892; pp. 158 (out of print).

Bulletin No. 36, Division of Chemistry, Department of Agriculture. Experiments with Sugar Beets in 1892; edited by H. W. Wiley, 1893; pp. 74 (out of print).

Bulletin No. 39, Division of Chemistry, Department of Agriculture. Experiments with Sugar Beets in 1893; by Harvey W. Wiley, with the collaboration of Walter Maxwell, 1894; pp. 59.

MISCELLANEOUS BULLETINS AND REPORT.

Special Report No. 28, United States Department of Agriculture. Report on the Culture of the Sugar Beet and the Manufacture of Sugar Therefrom, in France and the United States; by Wm. McMurtrie, 1880; pp. 294 (out of print).

Farmers' Bulletin No. 3, United States Department of Agriculture. Culture of the Sugar Beet; by H. W. Wiley, 1891; pp. 24 (out of print).

Farmers' Bulletin No. 52, United States Department of Agriculture. The Sugar Beet: Culture, Seed Development, Manufacture, and Statistics; by H. W. Wiley, 1897; pp. 48.

PLAN OF THE INVESTIGATIONS FOR 1897.

On the 11th day of January, 1897, the following letter was addressed to the Secretary of Agriculture:

SIR: Numerous inquiries for sugar-beet seed have come to this division instead of to the seed division, and I am unable to give any definite answer to our correspondents in respect of the policy of the Department regarding the distribution of the seeds in question. I would be glad to know if it would be possible for the Department of Agriculture to provide a few thousand packages of high-grade beet seed which could be distributed to inquiring farmers. There is a widespread interest in this country in the sugar-beet industry, and it appears to me that a part of the money voted by Congress for the distribution of seeds could be very profitably used in supplying experimenters with the best quality of sugar-beet seed. Farmers can not be certain in buying beet seeds from dealers that they are getting anything more than the ordinary quality of garden seeds. The guaranty of the Department, however, that they are securing high-grade sugar-beet seeds would be of great advantage.

I am now engaged in a revision of Farmers' Bulletin No. 3, to be used in supplying the information which is so largely asked for respecting the culture of the sugar beet and the manufacture of sugar therefrom. It would be of interest to make a statement in this bulletin in regard to the possibility of securing the seeds from the Department. An early reply to this inquiry will be appreciated.

I am, respectfully,

H. W. WILEY, *Chief of Division.*

The honorable the SECRETARY OF AGRICULTURE.

In reply to this request, in the following letter the information was conveyed that no funds were available for the purchase of beet seeds:

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE ASSISTANT SECRETARY,
Washington, D. C., January 13, 1897.

DEAR SIR: The Secretary has handed me your letter of the 11th instant, calling his attention to the advisability of distributing some sugar-beet seed in connection with the present Congressional seed distribution.

If this matter had been mentioned in time it would have been possible to purchase a supply of beet seed. As it is now, however, the whole appropriation for the purchase of seed is exhausted. There is not a dollar left with which sugar-beet seed could be purchased. If you will bring the matter up early next June it will be possible to include sugar-beet seed in the distribution of the following year.

Very truly, yours,

CHAS. W. DABNEY, Jr., *Assistant Secretary.*

Dr. H. W. WILEY, *Chemist.*

All further attempts to reestablish the investigations looking to the introduction of the sugar-beet industry in the United States, which had been suspended during four years, were therefore deferred to await the action of the new Administration.

Immediately after Secretary Wilson assumed the duties of his office, arrangements were made for a renewal of the investigations, but that date was entirely too late to purchase seeds directly from the growers in Europe; therefore arrangements were made with the Oxnard Beet Sugar Company, which kindly offered to donate the quantity of seed required for the purpose. As rapidly as possible the seeds were sent

to different parties in the United States interested in the subject, special attention being given to distributing the seed in those localities where the theoretical conditions for the production of sugar were the best. Packages were sent directly to the addresses of parties in different parts of the country, and large quantities of seed were distributed through the media of agricultural experiment stations, boards of trade, business men's associations, and others interested particularly in the culture. It is impossible, therefore, to determine the number of persons who were actively engaged in the work during the year.

In so far as possible the cooperation of the agricultural experiment stations was secured, it being deemed advisable to conduct the experiments in each State under the direct auspices of the State authorities. It was only when such cooperation could not be secured or where preference was shown for direct communication with the Department of Agriculture, and in miscellaneous cases, that the experiments were conducted directly under the auspices of the Department. Copies of Farmers' Bulletin No. 52, containing directions for planting and cultivating the crop, were sent to every person directly interested in the experiments, as well as to many others.

The promiscuous method of investigation which has been practiced during this and preceding years is faulty and unsatisfactory. In former reports the objections to such investigations have been outlined. In Bulletin No. 27 of this division (on pages 6, 7, and 8) is found a number of statements relating to the general conduct of experimental work, which are still pertinent. Inasmuch as this bulletin is out of print, it will be found of interest to repeat these statements here:

It must be understood that the object of this bulletin is not to give a complete treatise upon the culture of the sugar beet and the manufacture of sugar therefrom, but simply to indicate, for the information of those interested, the general principles of this industry. One especial object which will be kept in view is to prevent those intending to engage in this industry from going wrong in the beginning and squandering their money and time in battling with problems which science has already met and overcome. It is further hoped that the careful study of the data presented will prevent any mistakes from being made which would end in financial disaster and which are so apt to attend the early history of every industry.

There will probably be found for many years to come in the United States more enthusiasm than knowledge connected with the sugar beet, and the result of this will be, unless great care is taken, that many ventures will be made which may result in financial disaster, disaster which could have been avoided by a thorough comprehension of the fundamental principles of the industry.

In so far as the manufacture of sugar from the matured beet is concerned, we are able to start at the present time with the accumulated knowledge and experience of three-quarters of a century of investigation. So perfect have the processes of manufacture become that nearly all of the sugar which is stored in the beet can be secured in merchantable form and by comparatively inexpensive methods. By the term inexpensive, however, it must be understood that the actual processes of manufacture are denoted and not the cost of the machinery. The various processes for the extraction of the sugar from the beet, the best methods of clarifying the juice and of evaporating it and for separating the sugar from the molasses, are thoroughly

well understood and are no longer legitimate subjects for public experiment. The great problem in this country is the agricultural one. The selection of suitable soil, the finding of the proper climatic conditions, and instruction in the method of planting, cultivating, and harvesting the beets, are all matters of vital importance. Without a careful study of these subjects, and without the proper knowledge thereof, it is a hopeless task to attempt to introduce successfully the beet-sugar industry into this country.

One of the great dangers to be avoided is the formation of hasty conclusions in regard to the proper localities for the production of the sugar beet. Often without any study whatever of the climatic conditions or of the character of the soil, efforts are made to build large and expensive factories, which as often have to be abandoned on account of having been wrongly located. The studies which have been made heretofore in regard to climatic conditions have been of such a nature as to locate, in a general way, the areas in the United States suitable for the culture of the sugar beet.

It has been found in general that the coast valleys of California, and probably large areas in Oregon and Washington, certain parts of the Dakotas and Nebraska, localities in Minnesota, Iowa, Wisconsin, and Michigan, parts of northern Illinois, Indiana, Ohio, and New York present favorable conditions for sugar-beet culture; but in the regions thus broadly intimated there are certain restricted areas most suitable to the sugar beet, and it is only these restricted areas to which we must look for success. The fact that in one locality, for instance in Nebraska, good sugar beets can be produced would be no warrant whatever for assuming that all parts of that State were equally suitable for this purpose, and this remark may be applied to every one of the States mentioned above.

Sugar beets have also been raised in other sections in the United States, notably in New England, New Jersey, Delaware, and Kansas, and while there may be areas in the New England States where beets can be successfully grown, it must be admitted that the States last named stand in the second rank of beet-sugar producing localities. In Kansas, during the last year, as will be shown in the body of this report, sugar beets were grown and a considerable quantity of sugar manufactured therefrom. This, however, does not show that Kansas will be able to compete with more favorable States in the production of beet sugar.

In general, it may be said that the summers in Kansas are too hot to expect the production of a sugar beet uniform in its nature and containing a high percentage of sugar.

If the sugar-beet industry is to succeed in this country, the success must come from sharp competition with the same industry in older countries, where its conditions are better understood and where the localities suited to it have been selected by long and often costly experience. It must also compete with the sugar-cane industry, both of this country and of tropical countries, and for this reason we can only expect it to survive in those regions where soil and climatic conditions, proximity to fuel, cheapness of labor, and other favorable environments are found.

It is to be hoped that the mistakes which have so long threatened the sorghum-sugar industry with destruction may be avoided with the sugar beet. Calm judgment and sober reason must not give way to enthusiasm and extravagant expectations. All conditions of success must be carefully studied, all the difficulties in the way of success must be intimately investigated and surmounted, and ample capital, coupled with judicious perseverance, must be enlisted in its behalf.

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For the proper erection and completion of a beet-sugar factory not less than twelve months should be allowed, and even in this time it can only be properly accomplished under experienced technical control.

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In Bulletin No. 30 (on page 7) the following observations are found:

Only in a few instances were the directions of the Department followed out to the letter. In most cases the planting and cultivation of the beet seed were conducted according to such methods as the agriculturist might hit upon at the time. From the information gathered it was found that the chief variation from the instructions was in the preparation of the soil. In very few cases was a subsoil plow used and most of the beets which were sent to the Department were evidently grown in soil of insufficient depth. In some cases, where the exact directions for cultivation were carried out, the character of the beets received showed by contrast with the others the absolute necessity of employing the best methods of agriculture for their production.

In Bulletin No. 33 (on page 9) the following statement is made:

One of the most striking features in regard to this method of conducting experimental work is found in the fact that it is almost impossible to secure compliance with directions. It is evident, at once, that the value of experimental work depends upon the care with which it is done and the accuracy with which the directions prescribed are followed. It is not to be wondered at that farmers, busy with their other occupations, failed to comply with the minute directions necessary to secure the greatest advantage in experimental work.

Very few of the blanks were returned properly filled out. In many cases the data which were returned were palpably erroneous. In one instance a yield of 99 tons per acre was reported, and in a great many cases the reported yield per acre was so great as to show inaccuracy on the part of the measurement of the land or the weighing of the beets. In making out returns for such reported phenomenal yields the theoretical quantity of sugar per acre given was always questioned. We are accustomed to look with suspicion upon any yield of sugar beets which exceeds 25 tons per acre. While it is not impossible to secure a higher yield than this, and of beets of good saccharine quality, yet it is so rare as to throw doubt upon miscellaneous data showing an excess of that yield.

Another point, which makes the returns obtained less valuable, is found in the fact of the length of time which necessarily elapsed between the harvesting of the beets and their reception at the laboratory. Nearly all the samples received were from distant States, requiring for packages of this kind from three to eight days in the mails. Although the beets were in most cases well wrapped, according to directions, our experiments have shown that they must have lost a considerable quantity of moisture by evaporation during their long transit. The data, therefore, showing the content of sugar in the juice would be uniformly too high for normal beets. It is estimated that not less than 10 per cent should be subtracted from the number for sugar to express the normal percentage of sugar in the beets as originally harvested.

In Bulletin No. 36 (on page 28) the ideas outlined above are somewhat expanded in the following words:

Before proceeding to discuss the data in the preceding tables, attention should be called to the fact that in previous reports of this kind some dissatisfaction has been expressed in some States on account of the poor showing of the samples therefrom. In former reports attention has been particularly called to the probability that the data obtained by this method of experimentation are not wholly reliable and in all cases do not truly represent the capabilities of any locality for beet-sugar production. It is true that a large number of data received from a given State will indicate, in a general way, whether or not that State is capable of producing a good sugar beet, but where the number of data is limited, it may be that the agricultural conditions under which the samples were produced were so poor, or the season so exceptional, as to prevent a fair judgment of the capabilities of the soil and climate. On the

other hand, the culture which the samples received may have been so careful and the seasonal conditions so favorable as to produce a beet far above the average which could be produced in the whole State.

Again, the loss of moisture during transportation, or the failure of the farmers to send their beets in as soon as harvested, may tend to reduce the amount of water present in the beet and to raise correspondingly the quantity of sugar therein. Inasmuch as the analyses are made on the expressed juice, this would tend to show always an increased amount of sugar over that present naturally in the beets.

All these disturbing influences must be taken into consideration in judging the data which have been recorded. This has been said in general explanation so as to forestall any criticisms which may be made of the value of the data obtained.

To illustrate more particularly what is meant, attention is called to the instance, say, of Colorado and Montana. From the State of Colorado one hundred and twenty-three samples were received for analysis, and from the State of Montana only one sample. Any comparison, therefore, between the average results of the two States would be simply absurd. While one hundred and twenty-three samples from Colorado, showing, as they do, fine possibilities of sugar-beet culture, indicate that the State of Colorado is capable of producing beets of high quality, the single sample from Montana, whether it proved exceptionally poor or exceptionally fine, could have been no criterion by which the capabilities of the State for beet sugar could be judged.

In connection with the tentative results which have been obtained by this kind of work should be considered the characteristics of the soil and climate of each locality, and by putting the two together a fairly good idea can be formed of the possibilities of beet-sugar production. The reader should carefully bear the above explanation in mind, both in looking over the data in the tables and in reading the remarks thereon which follow.

In Bulletin No. 39 (on page 8) in commenting on the results of the year's work, the following statements are made:

The general results of the work this year are somewhat discouraging as compared with previous years. Throughout a great part of the beet-growing region the summer was excessively dry, and large numbers of total failures were reported.

In former reports attention has been called to the fact that the present method of experiment is unsatisfactory, and the reasons therefor have been fully set forth. The farmers are so busy with other work that, as a rule, they are not able to give careful attention to the experimental details. They do not have the time to suitably prepare the soil for beet culture, nor do they give the growing beet proper attention. When the time for harvesting comes they are usually engaged in other farm work, so that the beets are not harvested at the right time, nor are data obtained by means of which any accurate estimate of the yield per acre can be determined. The analytical data, therefore, of such work are usually fragmentary and far from teaching any definite lesson in regard to the industry itself. In general, however, the data bear out those of previous years in showing the areas in this country where the best beets can be grown. It is in these regions that the development of the industry must be expected.

There is probably not a State or Territory in the Union which is not capable of growing a fair article of sugar beets. Even in the far South beets of fair sugar content have been produced, and with good tonnage; but when the competition of the world is to be met, with the price of sugar as low as it is now, only those parts of the country where the soil and climate are especially favorable can be expected to compete successfully with the beet-sugar industry already firmly established in older countries. The sole valuable lesson, therefore, of the promiscuous distribution of beet seed is in the fact that, as a rule, those regions best suited to the growth of the sugar beet will gradually be outlined, and intending investors led to the proper localities for the establishment of factories.

The great success of the beet-sugar industry on the Pacific coast leads to the conclusion that if the northern part of the eastern and central portions of our country is to become the seat of a great sugar industry, every possible advantage must be taken of soil and location, in order to compete successfully with the beet fields of California, Washington, and Oregon.

The experience of the past season, as will be seen from the data in the following pages, has served only to give additional point to the observations made in previous bulletins.

The sugar-beet industry in this country has now reached a point where it is incumbent upon the National Government to secure a complete and accurate agricultural survey of the country in respect of growing beets. The competition in sugar making is now so keen that only those localities where natural conditions are best will, in the end, be found sustaining the industry. If we depend upon costly experiment to delimit these localities, hundreds of thousands of dollars will be wasted in the attempt. At a comparatively small expense, the Department of Agriculture will be able to have made careful and accurate surveys, based upon experimental data, to point out the regions where the sugar industry is most likely to succeed. This, however, can not be done by the promiscuous kind of experimentation which the Department has been compelled heretofore to pursue. Up to this time a sufficient scientific interest in the matter has not been aroused among the people to secure the kind of a survey which is necessary. Now, however, the conditions have changed. The agricultural experiment stations in most of the States are thoroughly aroused in this matter. They are willing, with the cooperation of the Department, to undertake an agricultural survey of their respective localities. In addition to this, intelligent men, either in their capacity of private citizens or as representatives of boards of trade, or of business men's associations, are ready to supervise, in limited districts, series of experiments which will give satisfactory answers to the questions which must be answered before the sugar-beet industry is fully established. It will therefore be the object of the Department in subsequent work, especially that of 1898, to secure in each locality interested in the matter, a few carefully conducted experiments. To this end it is urged that the experiment stations in the various States arrange with 25, 50, 100, or more representative farmers, who can be relied upon to do good work, to grow plats of beets in size of not less than half an acre.

CLIMATOLOGY.

It is evident that one of the first things to be considered, after the soil itself, in connection with the sugar-beet industry is the climate. The sugar beet is a plant very susceptible to climatic conditions. At the beginning of its growth the beet plant is peculiarly helpless. It can not lift, in passing from the germ to the new plant, the lightest clod. A rain which packs the surface of the soil immediately after germination will sometimes prevent the plant from reaching the light.

After the plant is established it requires a considerable quantity of water for its proper growth; this water must be supplied either by the rainfall of the locality, by irrigation, or by the subsoil. High temperatures extending over long periods of time are peculiarly injurious to the storing of sugar in the tuber. While high temperatures may not diminish the tonnage yielded by a field, nor apparently produce any injurious effects, in so far as the external appearance of the mature plant is concerned, it will be found, as a rule, that plants grown under such conditions of temperature are less rich in sugar than others grown in a milder climate. Since the production of sugar in the leaf of a plant is a joint function of the chlorophyll cells and sunlight, it is found that the high northern latitudes, where the summer days are exceptionally long and the nights correspondingly short, tend to produce, other conditions being the same, a beet rich in sugar. The climatic conditions of this country are so different from those of Europe as to render of little value the general conclusions which experience has drawn from the effect of climate, in the beet-sugar producing countries of Europe, on the sugar content of the beet itself. Nevertheless, it is seen that in Europe the great centers of the beet-sugar industry are in regions far to the north, in fact, so far north as to make it impracticable ever to expect, in this country, to establish the centers of the industry on the same parallels of latitude. When it is considered for a moment that the great capitals of Europe—St. Petersburg, London, and Berlin—are situated 1,460, 870, and 940 miles, respectively, north of Washington, and yet in prosperous agricultural communities the above statement does not create surprise. The vicissitudes of climatic conditions in northern Europe are also less marked than they are in the United States. Throughout the beet-growing area of Europe it is expected that the summers will be mild. They are not attended with many days of excessive heat. Spring comes early and permanently; the autumn comes slowly and late. In France and Belgium a severe frost is not expected in May, nor is it anticipated that ice of a considerable thickness will form in October. The summer days in these localities are considerably longer than even in the more northern portions of our country, and at least an hour longer than in the centers of our greatest agricultural prosperity. We find, therefore, so great a deviation in their climatic conditions that we can not apply with rigidity in this country the rules respecting the climate deduced from the experience of European countries. With those rules applicable in this country, it would be easily demonstrable that the great center of the sugar-beet industry on this continent would be in Canada, and not in the United States. We have, therefore, had to depend so far largely on theory in the application of the principles of climatology in the culture of the sugar beet in the United States. The experimental data which have been at our disposal have been fragmentary, and, as has already been noted, have not been secured in the systematic way desirable. The result is, even to-day, that many of our theories

Map showing mean Isothermal Lines of 68°, 69°, 70°, and 71° F. for the months of June, July, and August, and mean temperatures for the same months at other points in the State of New York and parts of adjacent States on the east. Heavy and light shading shows probable areas best suited to Beet Culture.

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in regard to climate are not yet substantiated by facts. In the light of the data at hand, in the publication of previous reports it has been assumed that the beet-sugar zone of the United States would be found located over an area of which the southern limit would be marked by the mean isotherm of 71° F. for the summer months of June, July, and August. While this temperature is considerably higher than the mean temperature of the European beet-sugar areas for the same period of time, it has always been evident that the beet area of the United States would necessarily be situated farther south than the like area of Europe. There are two reasons which make this location imperative. In the first place, the more northern latitudes not only have late springs, but even after the spring is once established the occurrence of a heavy frost is not unusual. In the second place, these same latitudes have short autumns, and the occurrence of heavy frosts in late October or early November are not at all unexpected. As a result of this, the season for the growth and harvest of the beet is too short if we should apply for the mean summer temperature the same rules as obtain in Europe. It is evident, however, that the assumption of the mean isotherm of 71° for June, July, and August as the southern limit of the beet-sugar area is based upon so many independent conditions as to render it only useful as a working basis.

OTHER CONDITIONS.

In connection with the temperature must be considered the rainfall, the contour and the nature of the soil, the possibility of irrigation, the abundance of subsoil moisture, the proximity of coal, limestone, and water, price of labor, facilities for distribution and transportation, and many other matters which are important in a discussion of the subject. It is further evident that the tracing of a single isothermal line and the arbitrary addition thereto of a certain width of land on either side do not give even the proper theoretical thermal basis for a careful study of climatic conditions.

MAP OF THERMAL BELT.

For this reason, the present report is supplied with a new map (Plate I), which has been kindly prepared by the Weather Bureau at our request, in which the isothermal lines for June, July, and August have been traced with greater care and from data extending over a longer period of time.[1]

The result of these new studies has been to change from former maps, in some cases slightly and in some cases considerably, the position of the mean isotherm of 70° for the three summer months named. This change, as will be seen by consulting the new map, is most marked in

[1] Data supplied, through the courtesy of Mr. Willis S. Moore, chief of the Weather Bureau, by Mr. A. J. Henry. The map was drawn by the draftsmen of the Bureau under Mr. Henry's direction.

the case of the State of New York, where in former maps the mean isotherm of 70° was traced in a line running almost directly west from Albany to Buffalo.

CHANGES IN THE NEW MAP.

In the new map the influence of the Allegheny Mountains on temperature has been more carefully studied, and as a result there has been a considerable deflection of the isotherm of 70° to the south and southwest. The general trend of this isotherm from Albany is in a southwesterly direction until the Allegheny Mountains are crossed, where it turns in a westerly direction until it reaches its former location practically in the neighborhood of Cleveland, Ohio. The position of this isotherm from this point westward is so nearly the same as that of the other map as to require no particular mention. The State of New York, however, especially that portion of it lying between Albany and Buffalo, has peculiar thermal conditions, and these are shown in a special map of that State (Pl. II). A considerable area of the State with a mean summer temperature of 70° is found in the northwestern part in the neighborhood of Rochester, while between this area and the continuous isotherm of 70°, as traced upon the map, is a considerable space of territory where the mean summer temperature is considerably below 70°. This area, however, corresponds more nearly to the beet areas of northern Europe than any other portions of our country. The temperature and other climatic conditions in this area are more uniform by reason of the modifying effects of the Great Lakes on the winds which blow from the west and northwest. The experimental data which have been collected show, therefore, that this area, although in many cases the mean summer temperature is below 70°, is peculiarly suited to the production of beets of a high sugar content. The comparatively mild springs and autumns also favor the planting and harvesting of the beet, so that the conditions of this area are as favorable to the production of beets of the proper grade as those areas lying immediately contiguous to the mean isotherm of 70°.

TRIPLE ISOTHERMAL LINES.

As a single isothermal line passing across the country affords a very narrow basis for study, it has been deemed advisable in the map herewith presented to take as the nucleus of the isothermic sugar zone not merely the isotherm of 70°, but that belt of territory, varying in width, which is bounded by the isotherms of 69° upon the north and 71° upon the south. The isotherm of 70° is found between these two, usually occupying the center of the belt, or nearly so, but sometimes approaching more nearly the one or the other. If, now, we add to the outside of the belt of irregular width, thus outlined by the two isotherms mentioned, on the south a strip of country of varying width and on the north an area bounded by the limit of dangerous frosts, this area will

MAP SHOWING THE PROBABLE AREAS SUITED TO BEET CULTURE.

Brown Belt—Probable basic area of Beet Culture.

Light Brown Shading—Probable extension of Beet Culture beyond basic belt.

◉ Sugar Factory in operation

● Building for the crop of 1898.

○ Building for the crop of 1899.

Blue Lines — Boundaries of areas of annual precipitation.

Blue Figures—Inches of annual rainfall.

Red Lines—Isotherms of mean temperatures for June, July, and August.

Red Figures — Mean temperatures for June, July, and August.

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practically include the whole of the United States which, from theoretical conditions of temperature, is best suited to the growth of sugar beets of a high saccharine content.

BEET ZONE.

The shaded portions of the map herewith presented indicate in a general way this area. No attempt has been made to extend this lateral shading west of the Missouri River. The paucity of data for the western part of the country, in connection with the extreme vicissitudes of climate, renders of little value any extension of the thermal belt.

ANNUAL RAINFALL.

Connected with this study, the annual precipitation is of the utmost importance. There has therefore been marked upon the map, in the area covered by this belt, the mean precipitation, in inches, from 50 to 40, from 40 to 30, and so on down to the least recorded quantities of rainfall in the far western arid regions.

The mean annual precipitation is, of course, of importance in determining the relations of the different regions to the water supply and the need of irrigation. It is also important to know the mean precipitation for the months during which the chief growth of the crop and the harvest take place, namely, for April, May, June, July, August, September, and October. The mean precipitation for each of these three months, as furnished by the Weather Bureau for the localities mentioned, is indicated in the following tables:

Monthly averages of rainfall, April–October.

Stations.	Latitude.	Longitude.	Elevation.	Number of years.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Total.
MASSACHUSETTS.	° ′	° ′										
Amherst	42 22	72 32	235	61	3.1	3.9	3.7	4.5	4.4	3.4	3.9	26.9
Boston	42 21	71 04	12	79	3.8	3.7	3.2	3.6	4.3	3.4	3.8	25.8
Fall River	41 42	71 09	259	22	3.9	4.0	3.1	3.5	4.4	3.3	4.5	26.7
Fitchburg	42 36	71 50	433	32	2.9	3.8	3.3	3.7	4.3	3.2	4.1	25.3
Lowell	42 39	71 17	104	42	3.6	3.7	3.3	3.8	4.4	3.3	3.8	25.9
New Bedford	41 39	70 56	100	83	3.6	3.8	3.0	3.1	3.9	3.3	3.7	24.4
Springfield	42 05	72 35	70	47	3.2	4.2	3.8	4.5	4.5	3.4	4.2	27.8
Taunton	41 54	71 05	30	22	3.6	3.3	2.5	3.5	4.2	2.8	3.8	23.7
Worcester	42 16	71 49	473	43	3.7	4.1	3.1	3.8	4.5	3.5	4.4	27.1
CONNECTICUT.												
Hartford	41 45	72 40	38	27	3.0	3.6	3.0	4.1	4.6	3.2	3.9	25.4
New Haven	41 18	72 56	10	45	3.3	3.9	3.1	4.5	4.6	3.8	3.8	27.0
New London	41 21	72 05	8	26	3.7	3.6	3.2	4.0	4.7	3.4	4.4	27.0
Middletown	41 33	72 39	37	33	3.4	3.8	3.5	4.3	4.8	3.6	4.1	27.5
Southington	41 35	72 51	152	26	3.1	3.2	2.8	3.9	4.6	2.9	3.6	24.1
Wallingford	41 27	72 49	73	35	3.6	4.2	3.6	4.2	5.0	3.6	4.2	28.4
NEW YORK.												
Albany	42 40	73 45	32	69	2.8	3.6	4.1	4.2	4.0	3.5	3.5	25.7
Buffalo	42 53	78 53	587	27	2.5	3.4	3.5	3.2	3.2	3.3	3.6	22.7
Cooperstown	42 42	74 57	1,300	43	2.6	3.6	4.1	4.3	4.1	3.4	3.3	25.4
Gouverneur	44 25	75 35	423	21	2.1	2.7	2.7	2.8	2.3	3.1	3.4	19.1
Ithaca	42 27	76 30	375	36	2.2	3.4	3.7	3.5	3.0	3.0	2.9	21.7
New York City	40 43	73 58	52	61	3.4	4.0	3.8	4.0	4.7	3.4	3.6	26.9
North Salem	41 20	73 34	361	23	3.4	4.4	3.5	4.0	4.1	3.1	4.1	26.6

Monthly averages of rainfall, April–October—Continued.

Sections.	Latitude.	Longitude.	Elevation.	Number of years.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Total.
NEW YORK—cont'd.	° ′	° ′										
Oswego	43 29	76 35	335	26	2.1	2.8	3.4	3.1	2.6	2.8	3.3	20.1
Palermo	43 20	76 22	.....	42	2.3	2.8	3.3	3.3	2.7	3.2	3.4	21.0
Rochester	43 08	77 42	494	27	2.5	3.3	3.3	3.0	3.0	2.4	2.9	20.4
Utica	43 06	75 13	473	41	2.7	3.5	4.3	4.7	3.5	3.5	3.5	25.7
NEW JERSEY.												
Atlantic City	39 22	74 25	13	23	3.3	3.1	3.0	3.5	4.3	3.2	3.2	23.6
Lambertville	40 23	74 57	75	25	3.3	4.4	3.8	4.4	4.9	4.3	3.6	28.7
Newark	40 45	74 10	13	52	3.5	4.0	3.5	4.4	5.0	3.8	3.6	27.8
New Brunswick	40 30	74 27	48	43	3.7	3.9	3.9	4.7	4.9	3.8	3.4	28.3
South Orange	40 45	74 15	141	26	3.3	3.2	3.6	4.9	5.2	4.0	3.7	27.9
Trenton	40 14	74 45	33	24	3.7	4.1	3.9	5.5	5.3	4.0	4.0	30.5
Vineland	39 29	75 01	97	25	3.3	3.9	3.3	4.3	4.9	4.0	3.4	27.1
PENNSYLVANIA.												
Blooming Grove	41 23	75 09	.....	25	3.2	4.0	4.1	5.0	4.9	3.1	3.6	27.9
Dyberry	41 38	75 18	1,100	25	2.5	3.4	3.1	4.6	3.8	2.8	3.3	23.5
Erie	42 07	80 05	686	23	2.5	3.8	3.9	2.8	3.3	4.6	4.1	24.4
Gettysburg	39 49	77 15	624	24	3.5	4.0	3.5	3.4	3.6	3.0	3.1	24.1
Harrisburg	40 16	76 53	320	25	3.0	4.6	4.4	4.2	3.9	3.6	3.3	27.0
Pittsburg	40 22	79 59	745	54	3.0	3.5	3.6	4.0	3.4	2.9	2.8	23.2
Philadelphia	39 53	75 10	32	72	3.4	3.8	3.8	4.0	4.3	3.5	3.2	26.0
MARYLAND.												
Baltimore	39 17	76 37	68	26	3.4	3.8	4.0	4.7	4.0	3.9	2.9	26.7
Cumberland	39 39	78 45	639	24	2.5	3.4	3.8	3.4	3.2	2.8	2.3	21.4
Emmitsburg	39 43	77 20	498	12	3.5	4.6	3.9	3.4	3.3	3.8	3.8	26.3
Frederick	39 24	77 24	415	15	3.7	4.4	4.6	3.5	2.7	3.7	2.5	25.1
OHIO.												
Cleveland	41 30	81 42	582	41	2.7	3.5	3.9	3.4	3.1	3.6	2.8	23.0
Columbus	39 58	83 00	812	17	3.2	4.2	3.5	3.2	3.2	2.6	2.6	22.5
Marietta	39 30	81 26	611	69	3.3	3.9	4.1	4.4	3.9	3.1	3.1	25.8
North Lewisburg	40 11	83 35	1,030	25	3.1	3.9	4.0	4.4	3.3	3.2	2.2	24.1
Steubenville	40 25	80 41	663	39	3.4	3.9	4.0	4.0	3.9	3.5	3.1	25.8
Toledo	41 40	83 34	579	26	2.2	3.4	3.4	3.1	2.7	2.4	2.4	19.6
Wauseon	41 36	84 07	767	23	3.0	4.2	4.1	3.4	2.7	2.6	2.6	22.6
Westerville	40 04	82 46	850	35	3.0	3.4	3.8	3.9	3.3	3.1	2.1	22.6
INDIANA.												
Angola	41 36	85 00	1,052	11	2.9	4.5	3.7	2.7	2.7	3.8	2.3	22.6
Columbia City	41 09	85 30	863	16	3.4	4.5	4.1	3.2	2.7	3.9	1.9	23.7
Connersville	39 40	85 03	844	14	3.7	4.4	4.3	2.4	2.7	2.6	2.2	22.3
Farmland	40 11	85 10	1,040	14	3.4	4.7	4.0	2.8	3.5	3.6	2.0	24.0
Fort Wayne	41 05	85 07	815	13	3.2	3.9	3.8	4.9	3.4	3.2	3.0	25.4
Indianapolis	39 46	86 10	753	27	3.6	4.0	4.5	4.2	3.3	3.1	2.8	25.5
Lafayette	40 28	86 54	667	16	3.7	4.8	4.2	3.7	3.5	2.7	2.2	24.8
Logansport	40 45	86 22	586	19	3.5	5.0	4.2	2.9	2.9	3.1	2.5	24.1
Mauzy	39 37	85 23	.....	13	3.5	4.2	4.5	2.2	2.7	3.1	2.5	22.7
Richmond	39 51	84 53	850	26	3.6	4.3	3.9	3.5	3.9	4.1	2.8	26.1
Spiceland	39 48	85 18	1,063	28	2.9	3.8	4.4	4.1	3.3	3.1	2.2	23.8
Wabash	40 48	85 49	698	10	2.9	4.2	4.6	3.4	3.0	2.5	3.6	24.2
ILLINOIS.												
Athens	39 57	89 45	800	16	4.1	4.8	5.7	3.4	3.0	3.3	2.5	26.8
Augusta	40 12	90 57	674	19	4.0	4.1	4.1	4.8	3.6	4.1	2.9	27.6
Aurora	41 47	88 08	648	22	3.2	4.0	3.8	3.3	3.4	3.2	2.9	23.8
Chicago	41 52	87 38	589	30	3.0	3.7	3.7	3.4	2.9	3.0	2.7	22.4
Elmira	41 10	89 49	505	17	3.2	4.1	4.1	3.2	3.6	3.3	2.1	23.6
Galesburg	40 56	90 22	786	12	2.9	3.5	4.0	3.7	4.2	4.1	2.6	25.0
Geneseo	41 27	90 06	845	11	2.7	3.1	3.8	2.9	3.0	3.6	2.7	21.8
Havana	40 18	90 05	475	11	3.5	3.6	4.2	4.6	2.5	3.8	2.2	24.4
Hennepin	41 16	89 21	.....	13	3.0	3.7	4.1	3.0	2.8	2.6	2.7	21.9
Marengo	42 15	88 37	819	45	2.8	3.9	4.3	3.7	3.7	3.8	2.4	24.6
Mattoon	39 29	88 24	737	15	4.2	5.0	4.8	3.9	3.4	2.9	2.8	27.0
Oswego	41 40	88 22	670	16	3.0	3.9	4.0	3.1	3.0	2.8	2.8	22.6
Ottawa	41 22	88 48	688	25	2.9	4.0	3.6	3.6	2.9	2.9	2.3	22.2
Peoria	40 42	89 36	452	41	3.2	3.8	3.7	4.0	3.0	3.5	2.5	23.7
Philo	39 59	88 08	771	11	3.8	4.2	4.2	2.7	2.1	3.3	1.7	22.0
Pontiac	40 54	88 40	600	6	2.2	3.2	3.2	2.2	1.5	1.7	1.5	15.5
Rockford	42 15	89 05	730	22	3.3	4.0	4.8	3.6	3.2	2.4	3.2	24.5
Rock Island Arsenal	41 32	90 38	528	14	2.7	3.9	3.9	3.7	3.3	3.2	1.6	22.3
Sandwich	41 31	88 32	656	17	3.7	4.6	4.3	4.5	4.5	3.5	2.5	27.6

Monthly averages of rainfall, April–October—Continued.

Sections.	Latitude.	Longitude.	Elevation.	Number of years.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Total.
ILLINOIS—continued.	° ′	° ′										
Springfield	39 48	89 39	644	17	3.7	5.0	4.4	2.8	2.4	3.2	2.7	24.2
Sycamore	42 00	88 42	800	15	3.6	4.3	5.0	3.6	2.9	3.0	3.1	25.5
Watseka	40 48	87 45	640	7	3.7	5.6	3.7	3.0	2.4	2.9	2.6	23.9
Winnebago	42 17	89 12	861	18	3.2	4.0	4.1	3.5	3.2	3.6	2.3	23.9
Wyanet	41 30	89 45	750	11	3.8	4.6	4.5	4.2	4.7	4.8	2.4	29.0
WISCONSIN.												
Beloit	42 30	89 11	741	30	2.9	3.2	4.0	3.5	3.6	3.4	2.5	23.1
La Crosse	43 49	91 15	657	24	2.4	3.3	4.5	4.0	3.2	4.2	2.3	23.9
Madison	43 05	89 24	857	28	2.6	3.5	4.5	4.0	3.1	3 1	2.6	23.4
Manitowoc	44 07	87 46	593	33	2.4	2.6	3.6	3.5	3.2	3.0	2.6	20.9
Milwaukee	43 02	87 54	591	53	2.8	3.4	3.8	3.2	2.7	3.0	2.2	21.1
MICHIGAN.												
Detroit	42 20	83 03	580	46	2.6	3.1	3.8	3.6	2.6	3.0	2.6	21.3
Grand Haven	43 05	86 18	593	25	2.6	3.4	3.8	2.8	2.7	3.6	3.2	22.1
Grand Rapids	42 57	85 40	604	14	2.8	3.6	4.2	2.4	2.4	3.4	2.5	21.3
Kalamazoo	42 20	85 38	770	20	2.6	4.4	4.5	3.2	2.6	3.2	2.8	23.3
Lansing	42 44	84 32	836	33	2.4	3.4	4.0	3.1	2.7	2.9	2.5	21.0
Port Huron	43 00	82 26	584	22	2.1	3.4	3.5	2.4	2.6	2.6	2.8	19.4

STUDY OF PARTICULAR LOCALITIES.

North Carolina and West Virginia.

The elevated areas of the mountain regions of North Carolina and West Virginia afford conditions of temperature and precipitation which are favorable to the growth of sugar beets. The rough and mountainous character of this portion of the country, however, presents mechanical difficulties in cultivation of sufficient magnitude to warrant the statement that the beet industry on a large scale is not likely to be established within it. A portion of the region specified has a mean annual rainfall of more than 50 inches, while the most of it is supplied with a rainfall of 46 inches. It is not probable, on account of the consideration mentioned above, that the beet-sugar industry, on a scale of any magnitude, will ever be established in the regions specified.

Eastern Shore of Maryland.

The isotherm of 71° enters Maryland at a point about the center of the Atlantic coast of the eastern shore, and runs north by northeast almost to Poughkeepsie, N. Y. It is evident, therefore, that the temperature conditions of this region are similar to those on or south of the isotherm of 71° in other parts of the country, although here in this area the region lies to the west of this isotherm. Judged by this factor, and also by the mean annual rainfall, which is 40 inches for this locality, the cultivation of the sugar beet might be successfully inaugurated along the Atlantic coast of the eastern shore; in fact, practically over the whole of the southern portion of the eastern shore of Maryland. The character of the soil in this locality is mostly sandy, and its natural fertility has been considerably diminished by long years

of cultivation. There is no reason to doubt, however, the fact that with proper fertilization and cultivation the requisite degree of fertility for the production of sugar beets could be secured. The general tendency in this region is in the direction of a too high temperature and too few hours of sunshine. The above observations apply also to Accomac County, Va.

Delaware.

The observations which have been made in regard to the eastern shore of Maryland also apply to the eastern region of Delaware. On account of the ravages of the "yellows" among the peach orchards of southern Delaware, it might be worth while for the agricultural experiment station to make a careful survey of the southeastern portion of the State with reference to the possibility of producing sugar beets of the requisite degree of saccharine strength. The surface of the soil is generally level; a good deal of it is of a sandy nature, and so far as its physical properties are concerned, it may be regarded as favorable to beet growth.

New Jersey.

The mean isotherm of 71° degrees passes northward almost parallel to the Atlantic coast of New Jersey, and at varying distances therefrom. The part of New Jersey lying between this isotherm and the seacoast is mostly composed of sandy soils, reasonably level. There are no mechanical difficulties of any magnitude connected with the culture of the beet, and the problem of fertilization of the soil is one which is easily solved. The same observations in regard to possibilities of beet culture may be made of this region of New Jersey as have been made in respect of Maryland and Delaware. This general observation relating to the whole may be added:

We have in this area a mean summer temperature of 71°. In no place does it reach the isotherm of 70°. The whole region may therefore be regarded as representing that of a maximum temperature compatible with beet culture. It may be further said that the culture of the beet should only be pushed south and beyond the isotherm of 71°, where peculiar natural advantages, independent of thermal factors, are afforded. These natural advantages consist of exceptionally fertile soil, favorable contour of the surface, cheapness of fuel, facilities for transportation, etc. A large portion of the region which has been mentioned is devoted to truck farming for the markets of large cities, and it is doubtful if this remunerative form of agriculture could be replaced successfully with sugar-beet culture in competition with more northern localities, where richer beets can be produced. Nevertheless, the possible production of fairly good beets in the region indicated must be admitted from the point of view of temperature and precipitation alone.

Connecticut.

It will be observed that, both in respect of precipitation and temperature, the whole of Connecticut may be regarded as lying in the beet belt. From theoretical considerations, therefore, it could be predicted that beets grown in Connecticut would show a satisfactory content of sugar and possess a high purity. So favorable are the theoretical conditions in that locality that it would be advisable for the agricultural experiment stations of the State to make a systematic agricultural survey of the possibilities of growing beets. The valley of the Connecticut River affords a fertile field of experiment where the mechanical conditions of culture and the natural conditions of the soil are factors which favor success. There are large areas of the State, however, so broken in contour as to render the possibilities of beet culture unpromising, but wherever large bodies of fairly level land with good fertility can be found it is fair to presume that the culture of the sugar beet would be attended with success. Conditions which obtain in Connecticut are also found in the State of Rhode Island, although a portion of that State lies north of the isotherm of 69°. As will be seen farther along, however, in discussing the conditions of growth in New York, there are many localities in the United States north of the isotherm of 69° where beets flourish; in fact, it may be said that the possibilities of growing beets north of the isotherm of 69°, where reasonably mild autumns can be expected, are much better than south of the isotherm of 71°.

Massachusetts.

The valley of the Connecticut, in the State of Massachusetts, doubtless affords as fine facilities for beet culture as in the State of Connecticut. The greater part of the State lies north of the isotherm of 69°. As in the case of Connecticut, there are doubtless many regions in this State north of the isotherm of 69° where, owing to the mild autumns, the sugar beet may be expected to grow satisfactorily for sugar-making purposes. A large part of the State is unfitted, by reason of its contour and the nature of the soil, for the culture of beets, but at least the Connecticut Valley and similar stretches of soil might be used to good advantage for this purpose.

New Hampshire and Vermont.

These States, lying north of the isotherm of 69°, will have to contend in the growth of beets with the shorter growing season and less heat for the three months of June, July, and August for forcing the beets to maturity. Nevertheless, it is doubtless true that for a distance of 100 miles, or even more, north of the isotherm of 69° beet culture could be practiced with success on account of the longer summer days. Samples of beets received from Vermont and analyzed in this laboratory show

favorable contents of sugar, and high purities. Those grown also at the experiment station of Vermont, as will be seen farther on, afford encouraging data. The thing to be feared in these localities is not inability to grow a beet rich in sugar, but the possibility of being able to harvest and secure it properly before the advent of winter. These areas do not enjoy the immunity from sudden changes of temperature, due to the lake breezes, which is characteristic of the great plain of the State of New York between Albany and Buffalo.

New York.

In this State we have a remarkable variety of thermal conditions. The mean isotherms of 69° and 70° pass in a southwesterly direction from Albany into the State of Pennsylvania, following, in general, the trend of the ranges of the Allegheny Mountains. The influence of these high altitudes is seen in forcing these isotherms to the south. The southeastern portion of the State of New York lies, therefore, within the belt of isotherms peculiarly favorable to beet culture, with the exception of the valley of the Hudson from a point a few miles above Poughkeepsie to the mouth of the river. This valley, including the city of New York, has a higher temperature than that deemed most suitable to beet culture. As this valley is, however, unfitted by reason of its contour to the culture of beets, the above fact is of little importance. Passing to the west of Albany, the mean summer temperatures for the three months of June, July, and August are considerably below the standards which have been mentioned until the region immediately east of Rochester is reached, where again we find a mean isotherm of 70°, and about Palmyra of almost 71°. Southwest of this the mean temperatures of the summer are again below 69°. Nevertheless, a fairly satisfactory agricultural survey of this region has shown that it is capable of producing beets of high quality; and the effects of the lake breezes upon the climate have doubtless much to do with this condition. For instance, in regions in this area where the mean summer temperature is below 69° the autumns are far more mild than in the similar regions in Minnesota, so that the months of October and November can both be relied upon with great certainty for securing the harvest of the beets. As has been before mentioned, we have in this region a nearer approach to the conditions of beet growing in northern Europe than in any other place in the United States. This whole region, therefore, must be considered and included in the area of our country where the theoretical conditions, and where the actual conditions, of temperature and precipitation favor the production of a beet of high saccharine content. If we should leave out of the calculation the southern deflection of the isotherms of 69° and 70°, due to the Appalachian system, and connect directly the area, in the neighborhood of Rochester, where these temperatures obtain, with Albany, neglecting the intermediate temperatures, we should have the isotherms occupying practically the same position in this new map that

they were made to occupy in the former maps furnished by the Signal Office for this Department. In the absence of definite information on the subject, it is fair to presume that the former maps were made in this way, and this accounts for the discrepancy in the position of the isotherm of 70° found in these maps and in the one now presented. Abundant experimental data go to show that the total area of the State of New York south of Saratoga is well suited to the growth of beets, wherever the physical conditions of contour are favorable and the soil suitable. The map of the beet area has therefore been extended so as to include this region in the beet belt.

Pennsylvania.

A large portion of the State of Pennsylvania, from the thermal point of view alone, is well suited to the growth of beets. The position occupied by the belt of territory included between the isotherms of 69° and 71°, however, in the State of Pennsylvania indicates an area which, for physical reasons, is mostly unsuited to beet culture, as it covers principally the mountainous region of that State. The northwestern part of the State, especially the portion bordering on Lake Erie, has the same favorable conditions for beet culture as are found in the great valley of the State of New York; and the principal development of the industry in that State, for the physical reasons mentioned above, must be looked for in that section. South of the isotherm of 71° there may be favorable regions in the southern and eastern portions of the State, but the altitude has pushed the isotherms too far south to look for the best results in the southwestern part of the State, on account of the shorter days due to the more southern latitude. Where conditions of contour and fertility of soil are favorable, the whole portion of Pennsylvania north and west of the isotherm of 71° may be regarded as favorable to beet culture. The precipitation immediately west of the Allegheny Mountains is not so great as on the east, but there is an area in the extreme northwestern part of the State where the mean average precipitation is nearly the same as that east of the mountains, namely, between 40 and 50 inches.

Ohio.

The northeastern and northern parts of Ohio are well situated for beet culture. In general, the contour of the land is favorable, being reasonably level, and the soil is fairly fertile. The conditions in these localities are fairly comparable with those in the State of New York, except that the mean temperature is higher, the mean isotherm of 70° running in a northwesterly direction across the northern part of Ohio and entering the lake near Sandusky. It is probable also that to a considerable distance south of the isotherm of 71°, good beets can be grown, but where so large an area is found with more favoring climatic conditions, it is not well to push the industry too far south until more favorable localities are fully exploited.

Michigan.

A large part of the southern peninsula of Michigan is directly in the heart of the beet belt. The contour of the soil is also favorable, being reasonably level, with an average fertility, and the data which have been secured in actual experiments in those regions are of the most encouraging kind. There seems to be no doubt of the fact that this locality is among the best in the United States for beet culture, and the modifying influence of the lake on the autumnal climate must not be lost sight of.

Indiana.

The northern counties of Indiana, especially the northwestern, are situated in the beet area, and it is probable that the culture of the beet may be extended southward, as in the case of Ohio, as far as Fort Wayne and Lafayette, although it is not advisable for intending investors to locate in the more southern areas until the more northern have been fully exploited. The agricultural survey of the northern part of the State, undertaken by the experiment station at Lafayette, in conjunction with the work of this Department, will indicate finally with more accuracy than a mere theoretical map the most favorable conditions of culture. Great interest has been manifested in Indiana in the extreme southwestern portion, near Evansville, in the culture of the beet, and, as will be seen in the following data, many samples have been secured from that portion of the State. In many respects this region is most favorable to beet culture, particularly on account of the facilities for transportation, cheapness of fuel, and the fertility of the soil. The mean summer temperature, however, is so high as to cause grave doubts concerning the future success of beet growth in that locality.

The soil in northern Indiana is much like that of Michigan—sandy, reasonably level, and fairly fertile—and there is reason to believe that an industry profitable both to the farmer and manufacturer may grow up in that part of the country.

Illinois.

The northern part of Illinois is in the beet-sugar belt, and the conditions in respect of contour of the surface and fertility of the soil, facilities and cheapness of transportation, etc., are excellent for the sugar-beet industry. The character of the soil in northern Illinois, however, is quite different from that of northern Indiana and the southern peninsula of Michigan. It is mostly a prairie soil, dark and underlaid with clay, so that the physical conditions of culture are probably not so favorable as in the other sections just named.

Wisconsin.

Southern Wisconsin occupies a most favorable position for beet culture, and the data which have been obtained from that State by the agricultural experiment station at Madison, in conjunction with the

work of this Department, are favorable, and show great possibilities of success for the industry in that region. We begin to notice here the effects of the southwestern breezes in forcing northward the isotherms of 70° and 69°, and these hot breezes cut off from the culture of the beet large areas where soil and other conditions are extremely favorable. The same remark should be applied to the belt of country immediately south of the isotherm of 71° that has heretofore been made, namely, that there are doubtless many sections where the successful culture of the beet may be secured. This is dependent upon local conditions which must be determined by careful agricultural surveys in the future.

Minnesota.

The deflection in a northwesterly direction of the isotherms of 70° and 69° includes in the sugar-beet area a large portion of the State of Minnesota, especially the southeastern portion. Here there is no question of the growth of the crop and the production of beets of high saccharine qualities. The great point to be feared in this locality is the early approach of winter, and this is true of all the cis-montane western regions. We find here a drop in the rainfall from an annual average of 30 to 40 inches to one of from 20 to 30 inches. We therefore meet here a greater possibility of suffering from a dry season than in the regions of the East. As a rule, however, the quantity of rainfall during the growing season is sufficient for the production of a good crop.

Iowa.

A remarkable deflection of the isotherms of 69° and 70° is noticed in passing from Minnesota to Iowa. Not only are these isotherms deflected toward the south, but they actually take a backward course toward the east, so that their direction for a considerable distance is east of south. This brings the theoretical beet belt, so far as temperature is concerned, almost through the center of the State of Iowa. The well-known fertility of the soil of this State, with the generally level character of the surface, shows that the agricultural possibilities for the growth of sugar beets are great. In the greater part of the State the rainfall reaches 30 inches per annum, but in the northwestern part the approach to the arid region is shown by a dropping off of the average rainfall, so that it is between 20 and 30 inches. Nevertheless, experience shows that, as a rule, a sufficient rainfall is provided in all parts of the State for the growth of ordinary agricultural crops. The isotherms of 69° and 70°, after passing partly across the State of Iowa, take a sudden turn toward the north and west and pass out of the State again into Minnesota, where they reach a more northern latitude than Minneapolis. With the exception of the southwestern counties of Iowa it is fair to presume that almost the whole of the area of the State, in so far as thermal conditions and rainfall are concerned, is

suited to the growth of beets. Of course, in this matter, it should be remembered, that local conditions of soil, transportation, fuel supply, and other factors must be taken into consideration. Iowa also occupies a position where there is no tempering influence of the northwestern winds, so that it begins to feel the rigors of the winter at an earlier date than is experienced on the same isotherms east of the Great Lakes.

North and South Dakota.

The conditions which prevail in North and South Dakota are somewhat unique. From the highest position attained in Minnesota, at the border line between that State and North and South Dakota, the isotherm of 69° turns again east and south and suffers a considerable deflection, due doubtless to the lower altitude of the Red River Valley. Passing, however, into Dakota the isotherms are rapidly pushed northward by reason of the hot southwest winds which are so often experienced in the summer time in those localities. For these reasons the isotherm of 69° reaches almost as far north as Bismarck, and the isotherm of 70° is only a few miles south of it. From this point the isotherms of 69° and 70° run almost due south from North Dakota entirely across the State of South Dakota and into Nebraska. The most favorable beet-sugar belt, in so far as the temperature alone is concerned, would be the area bounded by the isotherms of 71 and 69 degrees, occupying a belt of considerable breadth running north and south through South Dakota into North Dakota, and southeast through North Dakota back into South Dakota. The depression due to the Missouri River causes an area of higher temperature to extend in a northwesterly direction into South Dakota. This area, although perhaps not so favorable to beet growth as the other, is still situated in a fertile country, and doubtless has many advantages for growing beets not possessed by the higher lands to the east and west of it. There is no question of the ability of both the regions within the area specified to grow beets of fine saccharine strength. Abundant experimental data have been secured from both the States to substantiate this statement. Caution, however, must again be given in regard to the sudden advent of the winters, especially in North Dakota, where sometimes in October, and usually in November, temperatures approaching zero or even below zero, degrees Fahrenheit, are observed. These sudden falls of temperature would prove disastrous to the beet harvests, and hence tend to restrict to a certain degree the spread of the industry in that country. Again, attention should be called to the fact that the whole of the areas in the two Dakotas, where the thermal conditions are best suited to beet culture, has an average annual rainfall of only from 15 to 20 inches. The danger of drought and the possible shortage or loss of the crop from that source are therefore increased, and we begin to approach an area where artificial irrigation must be looked to in many seasons. Probably, however, in the majority of seasons the rainfall in this vicinity would be sufficient to secure a good crop.

Nebraska.

A study of the position of the isotherms shows that the best part of the State of Nebraska, both as respects soil and rainfall, has an average temperature of more than 71° during the summer months. The most favorable conditions of temperature are found almost in the center of the State over an area of somewhat irregular shape, and occupying a position where the extreme distance separating the isotherms of 71° and 69° is the greatest of any in the country. In Nebraska the two isotherms of 69° and 70° run almost parallel, but the isotherm of 71° runs first in a southeasterly direction, then almost south, and finally almost due west, forming a stomach-shaped area occupying a portion of Dakota and the central portion of Nebraska. The agricultural and analytical data which have been obtained in Nebraska are very extensive, and it will be observed that both of the sugar factories which have been established in that State are south of the limit of 71°. It has been observed also, by those who have had access to the analytical data of these two factories, that the saccharine contents of the beets which have been delivered to them have not been equal to those of beets grown in more favorable localities in the United States. On the other hand, the insufficiency of the rainfall in the central and western portions of the State renders less certain the growth of sugar beets, and tends to crowd the sugar factories and the sugar industry into the wetter and more fertile portions, in spite of the fact that the temperature is higher.

The Arid Regions.

It will now be necessary to trace the theoretical sugar-beet belt, so far as thermal conditions are concerned, by States through the arid regions. There is so little of the area embraced in this belt which is subject to irrigation, that it is understood at once that the possible beet-sugar industry of that region must be confined to the most favorable localities. It is interesting to see, however, how the elevation produced by the Rocky Mountain range deflects the isotherms which have been traced in a generally westerly direction up to this point so far to the south. Passing from Nebraska, the isotherm of 70° runs in a southwesterly direction to a point southwest of Denver, whence it turns in a southeasterly direction to New Mexico, thence almost due south to near the Mexican border. Being deflected to the west, it ascends on the other side of the Rocky Mountain range in a general northerly and westerly direction, passing in a northwesterly direction through Utah, thence turning west and south in Nevada, being deflected again to the south by the Sierra Nevada range of mountains, which it crosses, passing from Nevada into California, whence it passes northward again along the western slope of the Sierra Nevada Mountains until it comes near the coast line in the northern part of California. Thence the isotherm of 70° is deflected southward, almost parallel with the coast line, until it passes into lower California. It is seen that all the coast

valleys of California are included in the thermal belt most favorable to beet culture. The greater part of the area included in the thermal belt which has just been traced across the arid region is totally unsuited, on account of the mountainous and rough region of the surface, for agricultural uses. It is therefore evident that it is only in isolated places, where the surface of the land is smooth and irrigation can be practiced, that beet culture can be established. In connection with the thermal belt, the map shows that the mean average rainfall in many cases does not exceed 5 inches per annum.

In addition to the continuous belt thus marked out, there are some areas of varying temperature which demand attention, as, for instance, the elliptical area bounded by the isotherm of 70° in Idaho, of which Boise City is the center, and another area bounded by the isotherm of 70°, within which an isotherm of 71° is found, in the State of Washington. There is also one locality in Montana, on the Yellowstone River, where the average summer temperature is 71°.

In so far as thermal conditions are concerned, vast areas of the arid regions could be devoted to beet culture if the other conditions of culture were favorable. The differences of elevation of the plateaus cause numerous sudden changes of temperature, so that there are doubtless many localities not marked on the map where the mean summer temperature is almost identical with that which has been already mapped out. By reason of the meagerness of data, experimental and otherwise, relating to this whole region west of the Missouri River, the shading showing the probable extension of the beet area beyond the borders of the basic thermal belt has been omitted. The general discussion of this thermal belt, accompanied as it is by the chart of precipitation, is not necessary at this point. In general, in connection with this study, the remarks which are made in Bulletin No. 27, on page 169, and repeated in Farmers' Bulletin No. 52, may be recalled with profit:

> The mistake must not be made of supposing that all the region included within the boundaries of this zone is suitable for beet culture. Rivers, hills, and mountains occupy a large portion of it, and much of the rest would be excluded for various reasons. In the western portion, perhaps all but a small part of it would be excluded by mountains and drought. Beginning at a point midway between the one hundredth and one hundredth and first meridian, as indicated by the dotted line, beets could be grown only in exceptional places without irrigation. On the Pacific coast only that portion of the zone lying near the ocean will be found suitable for beet culture.
>
> On the other hand, there are many localities lying outside the indicated belt, both north and south, where doubtless the sugar beet will be found to thrive. The map, therefore, must be taken to indicate only in a general way those localities at or near which we should expect success to attend the growth of sugar beets in the most favorable conditions other than temperature alone.

The present map (Plate 1) gives in greater detail than ever before the boundaries of this thermal belt, by reason of the fact that the

observations of the Weather Bureau have been more numerous, and have been compiled in a more systematic manner. It would be idle to assert that subsequent observations of the Weather Bureau may not change in a marked degree the boundaries of the belt which has been mapped. It is also quite true that the agricultural surveys which will be conducted by the several States will locate definitely, beyond the limits already outlined, the areas where successful beet culture will be practiced. I may venture the prediction, however, that these areas will be contiguous to the zone which is already mapped out, and that the future beet-sugar industry of the United States, when it shall have reached a magnitude sufficient to supply to our people a large part of the sugar they consume, will be located almost entirely within the areas which have thus been traced.

DATA FROM DIFFERENT STATES.

Two methods of collecting the data from States have been pursued. In the first place, those receiving seeds directly from the Department of Agriculture were supplied with Farmers' Bulletin No. 52, giving instructions for preparing the soil, and planting and cultivating the beets. Each person was also supplied with a series of blanks for the purpose of obtaining cultural and climatic data, and for securing as great accuracy as possible in the reports which were made. The data blanks used are represented in the following forms:

UNITED STATES DEPARTMENT OF AGRICULTURE,
Washington, D. C., August 15, 1897.

DIRECTIONS FOR TAKING SAMPLES OF SUGAR BEETS FOR ANALYSIS.
Prepared by H. W. WILEY, Chief of Division of Chemistry.

When the beets appear to be mature (September 15 to November 15, according to latitude and time of planting) and before any second growth can take place, select an average row or rows, and gather every plant along a distance which should vary as follows, according to the width between rows:

From rows 16 inches apart, length 75 feet.	From rows 22 inches apart, length $54\frac{4}{5}$ feet.
From rows 18 inches apart, length 66 feet.	From rows 24 inches apart, length 50 feet.
From rows 20 inches apart, length 59 feet.	From rows 28 inches apart, length $42\frac{9}{10}$ feet.

The beets growing in the row, of the length above mentioned, are counted. The tops are removed, leaving about an inch of the stems, the beets carefully washed free of all dirt and wiped with a towel. Where the row is not long enough to meet the conditions, take enough from the adjacent row or rows to make up the required length. Rows of average excellence must be selected; avoid the best or poorest. Throw the beets promiscuously in a pile and divide the pile into two parts. This subdivision, of one-half each time, is continued until there are about ten beets in a pile. From these ten select two of medium size. Be careful not to select the largest or smallest.

From all of the rest of the beets, save these two, the necks are removed with a sharp knife at the point indicated by the dotted line in the figure (fig. 1). The beets, including the two saved as a sample, are then weighed.

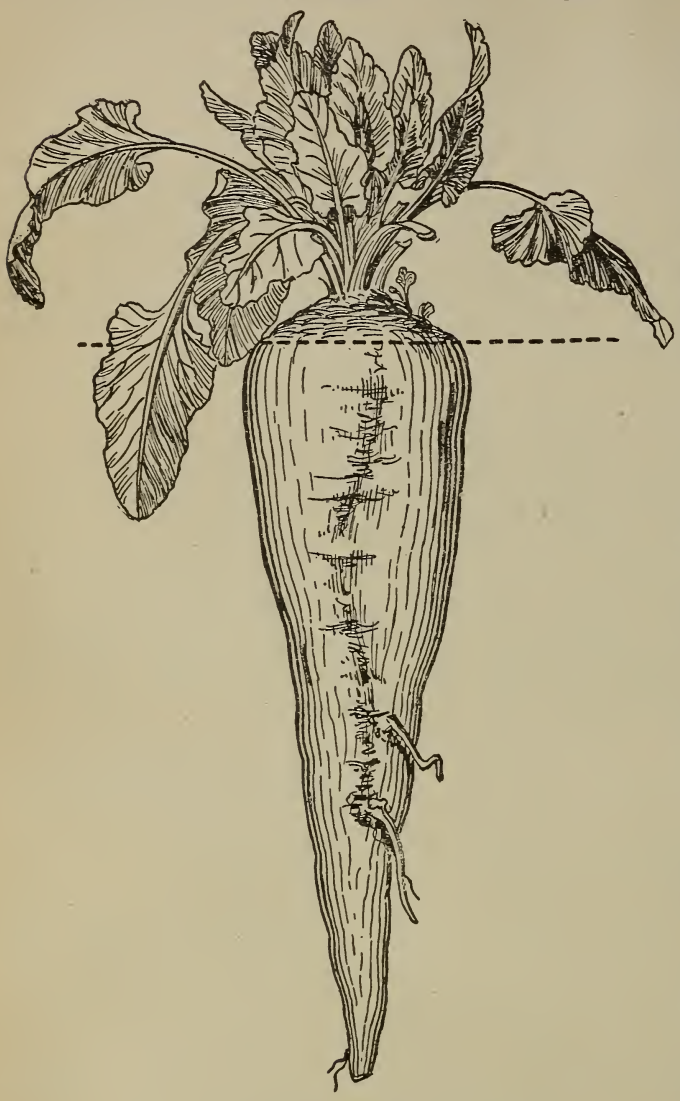

FIG. 1.—Illustration for removal of top of beet.

The number of beets harvested multiplied by 435.6 will give the total number per acre. The total weight of beets harvested multiplied by 435.6 will give the yield per acre.

Wrap the two sample beets carefully in soft paper, and write your name legibly thereon. The beets must be perfectly dry. Fill out the blank describing the beets, inclose it in the envelope, and sew it up in the bag with the beets. Attach the inclosed shipping tag to the bag and send the package by mail.

No beets will be analyzed which are not sampled as described above and properly identified.

Miscellaneous analyses of samples without accurate description are of no value.

Blanks are sent to each one for two sets of samples. From two to four weeks should elapse between the times of sending the two sets of samples.

If additional analyses be desired, other blanks will be sent on application, but not more than four analyses can be made for any one person, except in special cases.

A model, showing how blanks should be filled out, is inclosed.

[Model B.]

U. S. DEPARTMENT OF AGRICULTURE.

MODEL FOR DESCRIBING SAMPLE OF SUGAR BEETS.

Prepared by H. W. WILEY, Chief of Division of Chemistry.

Variety: Kleinwanzlebener.
Date planted: May 3, 1897.
Date thinned: June 3, 1897.
Date harvested: November 5, 1897.

Character of soil: Black prairie loam; in cultivation for 20 years, chiefly in corn; level, tile-drained; last crop, oats; no fertilizer was used; barnyard manure applied in 1895.

Character of cultivation (dates, implements, etc.): Plowed November, 1896, 8 inches deep, subsoiled 6 inches; harrowed with disk harrow May 1, 1897; rolled; seed planted with hand drill one-half inch deep; plants up May 16; stand excellent; hoed by hand May 22; plowed with horse hoe May 28 and June 8, 16, 24, July 3, 10, and 17.

Length of row harvested (feet): 66.

Width between rows (inches): 18.

Number of beets harvested: 88.

Total weight of beets, less necks and tops (pounds): 88.

Weather for each month: May, dry; June, copious rains; July, fine growing weather; August, hot and dry; September, dry until the 24th, when a heavy rain fell.

State: Iowa.

Post-office: Hanover, Buena Vista County.

Date: November 17, 1897.

Name: Robert Simpson.

NOTE.—Beets will not be analyzed unless accompanied with description as above.

It is evident that in promiscuous experimentation of this kind, even when directions are closely followed, and when all the operations are conducted in accordance with the directions in Farmers' Bulletin No. 52, and the procedure described in the blanks for taking samples faithfully followed, the data are still of an unsatisfactory nature. For instance, when a plot of beets has been harvested and quartered until the two beets required for a sample have been selected in accordance with directions, we still have an uncertainty prevailing as to whether the two beets correctly represent the whole lot. In fact, it is well known that the variations in the character of beets grown side by side are very great, far more so than is the case with sugar canes. As an illustration of this, the following analyses, giving the weight and sugar content of every beet grown in a row at the experiment station of Kentucky, is sufficient evidence:

Analyses of all the beets in a row, Kentucky station.

Serial No.	Weight after topping.	Sucrose in beets.	Serial No.	Weight after topping.	Sucrose in beets.	Serial No.	Weight after topping.	Sucrose in beets.
	Ounces.	*Per cent.*		*Ounces.*	*Per cent.*		*Ounces.*	*Per cent.*
1985	27	7.7	2009	8	8.2	2033	10	8.1
1986	25	9.9	2010	4	9.3	2034	10	7.2
1987	24	10.4	2011	1	9.9	2035	12½	9.1
1988	24	10.6	2012	1	10.5	2036	11	9.0
1989	20	8.6	2013	2	9.6	2037	11	9.8
1990	20	7.9	2014	3½	10.9	2038	9	8.8
1991	28	6.7	2015	3½	9.9	2039	9	7.4
1992	31	9.0	2016	34	8.2	2040	8	9.7
1993	18	10.4	2017	27	7.0	2041	11	8.9
1994	24	9.0	2018	20	9.3	2042	8	9.3
1995	53	4.8	2019	8	11.9	2043	9	6.9
1996	19	8.2	2020	16	6.2	2044	8	10.4
1997	33	2.6	2021	22	8.0	2045	7	9.4
1998	16	9.9	2022	15	6.8	2046	5	8.2
1999	2	10.7	2023	20	9.8	2047	4	8.4
2000	2	8.8	2024	26	9.0	2048	5	8.6
2001	2	9.6	2025	16	9.4	2049	4	8.7
2002	13	8.9	2026	18	9.7	2050	4	10.5
2003	8	9.6	2027	18	6.6	2051	4	9.3
2004	12	11.0	2028	15	8.6	2052	3	10.7
2005	6	10.5	2029	11	9.3	2053	2	12.2
2006	3	11.1	2030	17	4.9	2054	1½	10.6
2007	5	10.6	2031	12	6.8	2055	1	9.9
2008	1¾	10.2	2032	12	6.9	2056	1½	11.2

The great variations which exist, both in size and quality of beets, are most strikingly shown by the above figures. The variation in size extends from 1 to 53 ounces, and in sugar content from 2.6 to 12.2 per cent. When, however, it is considered that all overgrown and undergrown beets are rejected in taking the samples, and only those of medium size and perfect form selected, it is evident that the chances of the sample representing fairly the average of the whole lot are very much improved. Even granting this, however, it is unsatisfactory to depend upon the analysis of two or three samples alone for determining the character of the whole plot. It is evident, however, that on account of the nature of the method of investigation and the undesirability of burdening the mails with too many samples, it is impracticable to do better than has been done in this matter. The analyses of all of the samples which were sent to the Department of Agriculture from each of the States and Territories are given in the tables which are found farther along. For convenience of reference, the analyses are tabulated by counties in each case.

The second method of collecting data was through the cooperation of the agricultural experiment stations. To facilitate this, the Secretary of Agriculture appointed the directors of these stations special correspondents of the Department for distributing the seed and collecting the beets for analysis. The analyses were made by the chemists of the several stations, and they are given below, grouped under the various States. Where the cooperation of the agricultural experiment stations was secured, the reports are given by the director or officer in charge. Inasmuch as the details of these analyses are published by the various stations, including the names and residences of the persons who grew the beets, in the present report only the averages of the analyses by counties or sections, together with such observations as have seemed desirable, are given. The reports of the directors and other officers in charge contain much interesting material, and in some cases are given without abbreviation.

DATA OBTAINED IN THE LABORATORY OF THE DEPARTMENT OF AGRICULTURE.

The analytical data obtained during the season of 1897 in the Department of Agriculture have been classified as follows:

The data obtained from each State or Territory collected by counties or sections and the general average for each county are as follows:

The analytical tables showing the data of the Department samples contain the names of the States and counties arranged alphabetically. The name of each county is followed by a symbol in the shape of a square to designate the position of the county in the State. The plain square shows that the county is situated in the central portion, while a straight line attached to the center of the top of the square shows the county is in the northern part of the State; attached in a diagonal

direction to the upper right-hand corner, that it is in the northeastern portion of the State; attached to the center of the right side, shows it is in the eastern portion of the State; attached to the lower right-hand corner, that it is in the southeastern portion; attached to the center of the lower side of the square, that it is in the southern part; to the lower left-hand corner, in the southwestern; to the center of the left-hand side of the square, in the western part, and to the upper left-hand corner, in the northwestern.

The tables also state the number of samples received from each county, the average weight of the samples in ounces, the average per cent of sugar in the beet, the average purity coefficient of the juice, and the maxima and minima percentages of sugar in the juice and the coefficients of purity.

In many cases the quantity of juice was too small to compute the purity in the usual way, and in others the low percentage of sugar rendered the ascertainment of the purity unnecessary. These two reasons account for the omission in many instances of the number expressing the purity of the juice.

CAUTIONS REGARDING THE VALUE OF THE DATA.

It is highly important that the persons using the analytical data contained in the following tables be cautioned in regard to the value which should be attached thereto. It is evident, in the first place, that samples which have been grown in such a promiscuous way as those received by the Department, in so many different characters of soil, under so many different climatic conditions, and with such variable culture, water supply, and fertilizing materials, must lack that uniformity of value which should characterize scientific data in general. Attention has already been called, moreover, to the fact that the few samples of beets which have been sent can not be regarded as exactly representing the whole mass of which they originally formed a part. The variations in individuals are so great under practically identical conditions as to render somewhat doubtful data which are based upon a few samples alone. For instance, in the comparison of different States in respect of sugar-producing qualities, it may be that one State is represented by perhaps less than 50 samples, while others may have 500 or 1,000. In such cases the average of the 50 samples does not in any way present such convincing data as the average of 1,000. The greater the number of samples examined, the more nearly will the disturbing influences of individuals be eliminated. When it comes to a comparison of the counties in the several States, the same remarks are true. In many instances a county may be represented by a single sample. It may be that the sample is extremely good or extremely poor. In neither case is it representative. It would be unjust, therefore, to compare a county with one sample with another from which 50, 100, or 200 samples have been received. Even in the averages representing

the samples from a single county or locality care must be taken not to be misled. The samples may include, for instance, a very small beet with an excessive sugar content, or a very large one with a deficient sugar content. In case only two or three samples constitute the whole number, the influence of these abnormal samples is raised to a maximum. As an illustration of this, the analysis of samples from Clinton County, Ill., may be cited as a type of many others. Three samples were received from this county, the average weight of which was 13 ounces, and the average sugar content 15.7 per cent. One of these samples, however, weighed only 4 ounces, and had the abnormal sugar content of 21.2 per cent. It is evident, therefore, that the average percentage of sugar in the three samples is very much higher than it would have been had they all been normal in size.

Another point must not be forgotten, and that is, granting that the samples of any locality are representative, they represent only one season. That season may have been peculiarly favorable or unfavorable, and hence no section should be judged by the results of a single year's experiment. The reader who wishes to study critically the data which follow must take all these facts into consideration, and the judgment which he may form in regard to any particular section must be subject to the rectifications indicated by the variable factors mentioned above.

Table showing mean analyses and maxima and minima of the beets examined in the chemical laboratory of the United States Department of Agriculture during 1897, arranged alphabetically by States and counties.

State.	County.	Number of samples.	Averages.			Maxima.			Minima.		
			Weight.	Sugar in the beet.	Purity coefficient	Weight.	Sugar in the beet.	Purity coefficient	Weight.	Sugar in the beet.	Purity coefficient
			Ounces.	*Per cent.*		*Ounces.*	*Per cent.*		*Ounces.*	*Per cent.*	
Arizona	Apache	1	26	9.6	70.4						
	Pima	6	23	9.3		30	12.0		9	7.6	
Averages, etc.		7	23	9.3		30	12.0		9	7.6	
Arkansas	Phillips	1	19	10.6							
	Poinsett	1	17	11.9	71.5						
Averages, etc.		2	18	11.3		19	11.9		17	10.6	
California	Mendocino	1	26	16.8							
Colorado	Bent	2	19	17.1		20	19.4		18	14.7	
	Boulder	9	31	15.3	80.9	62	20.0	86.4	15	12.5	77.0
	Chaffee	2	22	15.5		28	17.4		16	13.6	
	Conejos	12	29	13.9	77.9	49	17.0	85.9	12	10.5	70.6
	Costilla	4	20	13.2	82.3	28	16.3	86.9	12	9.3	84.6
	Delta	2	20	17.1	80.5	23	18.6	84.3	16	15.5	76.7
	Douglas	5	23	15.1	76.8	34	18.7	85.5	12	9.6	69.4
	Eagle	1	14	14.5	81.7						
	Elbert	13	18	14.7	77.6	45	18.7	87.7	8	9.7	68.9
	El Paso	3	22	13.9	76.6	39	14.7	80.1	6	12.7	73.1
	Fremont	4	19	14.8	80.7	33	17.0	84.8	11	12.4	75.6
	Garfield	16	14	16.6	82.2	28	20.9	85.9	9	14.4	79.4
	Huerfano	1	14	17.8							
	Larimer	9	21	13.3	77.8	28	16.7	84.5	14	8.8	68.9
	Logan	23	15	9.6	73.8	43	16.5	83.3	4	4.1	63.4
	Mesa	4	29	15.1	81.9	49	17.6	88.1	18	11.9	75.6
	Morgan	34	16	12.0	75.5	32	16.1	82.8	6	8.1	68.0
	Otero	6	28	13.7	79.0	35	17.3	84.3	16	10.7	75.2
	Phillips	4	33	12.0	71.4	60	14.7	75.4	18	9.7	68.9
	Prowers	5	20	14.8	77.5	34	17.1	83.9	10	12.0	72.8
	Pueblo	1	16	20.2	85.9						
	Rio Grande	5	20	15.1	80.0	33	17.6	84.1	7	12.4	76.5
	Routt	2	10	18.8		11	19.0		10	18.6	
	Saguache	3	23	12.1		34	16.5		10	8.0	
	Washington	2	15	14.3	80.2	19	14.8	82.0	11	13.8	78.4
	Weld	2	34	14.8	86.5	40	16.2	87.0	27	13.4	85.9
Averages, etc.		174	20	13.6	76.7	62	20.9	88.1	4	4.1	63.4

Table showing mean analyses and maxima and minima of the beets examined in the chemical laboratory of the United States Department of Agriculture during 1897, arranged alphabetically by States and counties—Continued.

State.	County.	Number of samples.	Averages.			Maxima.			Minima.		
			Weight.	Sugar in the beet.	Purity coefficient	Weight.	Sugar in the beet.	Purity coefficient	Weight.	Sugar in the beet.	Purity coefficient
			Ounces.	*Per cent.*		*Ounces.*	*Per cent.*		*Ounces.*	*Per cent.*	
Idaho	Bingham	5	18	16.2	80.5	26	18.2	86.7	6	13.9	73.2
	Fremont	2	27	14.0	77.1	32	16.1	80.1	21	11.9	74.1
Averages, etc		7	21	15.5	79.4	32	18.2	86.7	6	13.9	73.2
Illinois	Bureau	1	15	11.6	78.1						
	Clark	1	18	13.8	86.8						
	Clinton	3	13	15.7	73.7	21	21.2	74.1	4	12.8	73.2
	Cook	6	12	12.7	76.8	17	18.7	78.4	6	10.0	75.2
	Cumberland	2	24	14.3	77.8	32	15.2	84.7	16	13.4	70.9
	Edwards	1	8	12.7	69.0						
	Effingham	2	8	11.1		8	11.8		7	10.3	
	Franklin	1	20	11.2	67.8						
	Henry	3	18	13.6	76.2	19	14.5	80.8	16	12.6	73.7
	Jackson	1	13	14.0	76.6						
	Jefferson	1	9	10.2							
	McHenry	1	57	11.9	73.0						
	Macoupin	1	12	16.1	72.2						
	Mason	1	30	12.6	81.0						
	Peoria	1	22	14.7	77.0						
	Rock Island	1	30	10.6	76.1						
	Saint Clair	2	12	16.4		13	16.6		10	16.2	
	Sangamon	2	14	12.4	69.9	16	12.8	72.0	11	11.9	67.7
	Union	1	26	8.3							
Averages, etc		32	17	13.1	75.5	57	21.2	86.8	4	8.3	67.7
Indiana	Allen	3	28	13.4	77.7	37	15.0	78.7	17	11.9	76.4
	Delaware	1	20	14.3	77.3						
	Elkhart	4	15	14.8	77.6	16	16.0	82.1	13	13.6	72.6
	Hendricks	1	14	13.9	82.9						
	Henry	8	17	13.1	78.5	25	15.9	81.6	5	9.4	73.1
	Knox	1	28	10.0	71.4						
	Madison	3	16	14.4	82.4	17	17.1	85.6	14	12.1	79.1
	Marion	1	9	15.1	81.9						
	Morgan	3	14	14.8	80.3	17	14.9	80.8	9	14.3	78.8
	Pulaski	6	16	13.5	73.2	20	14.9	78.4	10	11.9	74.6
	Rush	1	21	12.9	80.0						
	Starke	10	12.8	15.7	81.8	17	18.4	88.4	9	11.4	71.3
	Tippecanoe	17	7	15.1	81.1	20	19.1	84.4	3	12.3	78.2

	Union	2	15	14.7	79.8	16	15.3	82.9	14	14.0	76.6
	Vanderburg	40	14	11.2	77.3	42	13.8	87.7	7	7.8	71.4
	Warrick	1	14	8.2							
	Whitley	1	16	14.0	83.1						
Averages, etc		103	14	13.1	78.9	57	21.2	88.4	3	7.8	8.2
Iowa	Adair	1	19	12.6	74.2						
	Adams	3	19	12.9	75.4	24	13.4	78.8	17	12.2	68.8
	Allamakee	1	20	14.7	76.6						
	Appanoose	1	7	19.0							
	Benton	6	16	13.8	76.9	18	18.2	77.7	13	9.5	73.4
	Bremer	2	15	13.6	81.3	15	15.7	83.3	14	11.6	79.2
	Butler	1	48	10.7	72.7						
	Calhoun	2	10	18.1		12	18.1		10	16.1	
	Carroll	1	20	14.0	80.8						
	Cass	3	17	11.4	71.7	20	12.3	75.0	16	10.8	67.7
	Cerro Gordo	1	32	12.7	77.8						
	Clinton	5	11	16.8	75.8	12	18.2	77.7	9	15.4	73.2
	Crawford	2	20	8.5		24	11.0		15	6.1	
	Dallas	3	18	13.9	76.4	26	14.8	79.1	14	13.3	75.1
	Davis	2	15	16.1	72.4	20	16.4	74.1	10	15.8	70.8
	Decatur	1	16	15.6	79.2						
	Dickinson	1	15	10.9	69.7						
	Dubuque	1	17	10.0	68.3						
	Franklin	1	14	14.3	73.5						
	Greene	39	21	12.7	76.3	32	16.7	87.4	10	9.8	66.7
	Guthrie	6	23	12.5	78.8	30	15.0	84.0	17	10.0	74.5
	Howard	1	24	15.3	78.8						
	Humboldt	1	8	18.0							
	Jefferson	1	14	11.8	76.5						
	Keokuk	3	12	13.2		15	14.3		7	12.5	
	Kossuth	2	32	10.7	72.7	34	11.1	73.9	30	10.3	71.5
	Linn	1	10	11.8	67.7						
	Louisa	2	19	12.8	70.3	20	13.3	71.7	18	12.2	68.8
	Monona	1	13	13.8	78.8						
	Muscatine	2	18	14.3	80.8	18	14.3	81.0	17	14.2	80.6
	O'Brien	15	16	13.8	76.1	32	16.4	83.0	9	9.6	69.1
	Polk	1	10	11.3							
	Story	5	13	14.7	76.6	20	17.3	82.6	11	12.8	72.4
	Tama	3	20	11.9	78.0	24	13.5	80.6	15	10.7	74.9
	Van Buren	3	19	13.0	74.5	21	18.0	83.2	17	10.5	65.9
	Washington	3	18	13.7	78.8	26	15.0	84.8	14	12.5	71.3
	Wayne	1	10	14.0							
	Winneshiek	2	18	13.4	78.3	22	13.6	79.9	14	13.1	76.6
Averages, etc		130	18	13.3	73.7	48	19.0	87.4	7	6.1	65.9
Kansas	Allen	2	28	11.1	71.5	35	11.5	71.8	20	10.6	71.2
	Anderson	2	88	10.9	74.5	110	10.9	76.0	65	10.8	72.9
	Barton	26	24	11.0	72.4	57	13.3	78.3	10	7.2	65.7
	Clay	1	37	9.7	68.9						

Table showing mean analyses and maxima and minima of the beets examined in the chemical laboratory of the United States Department of Agriculture during 1897, arranged alphabetically by States and counties—Continued.

State.	County.	Number of samples.	Averages.			Maxima.			Minima.		
			Weight.	Sugar in the beet.	Purity coefficient	Weight.	Sugar in the beet.	Purity coefficient	Weight.	Sugar in the beet.	Purity coefficient
			Ounces.	*Per cent.*		*Ounces.*	*Per cent.*		*Ounces.*	*Per cent.*	
Kansas	Cloud	1	15	14.8	82.4						
	Douglas	2	26	12.7	80.4	28	13.3	80.8	23	12.1	79.9
	Lane	2	11	16.2	84.5	11	17.8	85.3	10	14.6	83.6
	Montgomery	2	15	11.2		21	15.7		8	6.6	
	Morris	1	34	11.5	70.4						
	Sedgwick	1	22	13.8	70.8						
	Woodson	1	35	10.8	73.5						
	Wyandotte	1	48	9.4							
Averages, etc		41	27	11.4	73.8	110	17.8	85.3	8	6.6	65.7
Kentucky	Daviess	1	9	15.7	83.3						
	Fayette	4	19	11.2	68.5	21	13.3	72.5	17	9.5	65.0
	Henry	1	10	11.1							
Averages, etc		6	16	11.9	71.5	21	15.7	83.3	9	9.5	65.0
Maryland	Anne Arundel	4	22	7.7	73.8	26	10.5	80.3	19	3.2	67.2
	Baltimore	3	21	9.8		38	11.1		8	8.9	
	Frederick	2	20	13.5	82.9	24	13.7	83.2	15	13.2	82.7
	Harford	4	13	13.8	78.9	16	15.7	82.7	7	11.6	76.6
	Montgomery	4	23	11.9	85.0	35	14.6	85.4	18	8.6	84.5
	Prince George	3	16	12.9	81.9	26	13.6	85.7	11	12.6	79.7
	Talbot	3	15	11.2	78.9	19	12.9	81.8	10	9.3	75.9
	Washington	5	18	11.8	73.5	25	15.6	77.1	12	8.0	66.8
	Wicomico	1	32	9.0							
Averages, etc		29	19	11.4	79.1	38	15.7	85.7	7	3.2	66.8
Michigan	Allegan	3	62	6.8		82	9.9		50	4.1	
	Alpena	2	18	13.7	81.2	24	14.4	85.4	12	13.0	77.0
	Arenac	1	26	8.9							
	Barry	1	19	15.2	83.7						
	Bay	5	24	14.2	80.5	40	16.2	83.7	16	13.2	74.6
	Calhoun	8	17	15.8	83.2	32	16.9	89.8	12	15.1	79.8
	Delta	2	17	16.4		24	20.2		10	12.5	
	Dickinson	2	18	14.1	81.4	18	14.1	81.4	17	12.7	75.6
	Genesee	1	28	14.6	81.4						
	Huron	3	19	15.3	81.9	24	16.2	82.9	16	14.2	81.0
	Isabella	5	24	13.3	82.2	26	16.4	86.8	20	8.2	85.7

	Kalamazoo	2	24	16.7	78.9	29	19.0	85.7	18	14.3	72.2
	Kalkaska	1	35	16.5	82.9						
	Macomb	3	13	16.8	80.8	14	18.6	83.2	10	13.3	78.3
	Manistee	1	14	15.5	87.1						
	Montmorency	1	22	15.5	84.0						
	Oakland	1	16	17.4	82.7						
	Ottawa	1	9	17.0	86.0						
	St. Joseph	1	22	11.6	77.2						
	Saginaw	399	22	14.8	83.3	37	19.6	91.0	9	9.8	67.9
	Sanilac	5	25	14.6	81.9	36	16.6	84.8	16	10.4	78.5
	Schoolcraft	1	28	12.3	73.8						
Averages, etc		450	22	14.7	81.1	82	20.2	9.0	9	4.1	67.9
Minnesota	Aitkin	3	31	11.5	79.7	51	15.4	81.7	10	6.9	77.6
	Carlton	1	14	15.0	84.8						
	Dakota	3	26	12.2	75.2	28	13.2	77.3	25	11.1	71.5
	Dodge	1	24	13.0	77.0						
	Freeborn	12	20	14.1	82.3	28	15.6	86.3	15	12.3	75.0
	Goodhue	8	23	11.7	76.1	36	13.8	83.5	16	7.7	72.7
	Hennepin	1	43	13.3	79.4						
	Mower	1	19	13.2	75.8						
	Nicollet	2	31	11.3	72.3	32	10.9	77.1	29	10.9	67.5
	Ottertail	4	23	14.9	82.1	30	16.0	82.3	14	13.5	82.0
	Polk	1	8	17.7							
	Redwood	1	30	12.0	75.9						
	Rice	1	18	13.7	82.7						
	Scott	1	14	10.9	73.5						
	Stearns	9	29	12.7	79.8	48	15.9	83.4	20	10.4	72.6
Averages, etc		49	24	11.0	79.2	51	17.7	86.3	8	6.9	67.5
Missouri	Adair	4	25	12.5	74.5	38	13.9	77.6	14	9.9	70.3
	Atchison	5	53	10.6	73.3	59	12.0	75.2	34	6.3	72.2
	Audrain	3	34	6.1		47	10.2		21	8.2	
	Barry	7	15	15.3	76.4	28	18.6	82.0	8	11.0	68.2
	Barton	3	27	15.3	77.3	34	16.5	77.9	22	13.5	76.4
	Bates	1	12	10.5	62.5						
	Benton	5	16	15.5	77.1	33	18.8	78.8	10	13.0	74.9
	Boone	2	11	11.1		12	12.6		10	9.5	
	Bollinger	1	14	15.6	67.8						
	Buchanan	2	30	11.0		43	13.7		16	8.2	
	Caldwell	7	25	11.2	72.5	41	12.6	76.7	12	9.5	70.0
	Callaway	5	19	9.9	77.0	29	14.6	78.5	10	4.1	74.0
	Camden	2	14	13.8	76.5	14	13.9	77.8	13	13.7	75.2
	Cape Girardeau	2	8	12.4		9	18.1		7	6.6	
	Carroll	6	27	11.8	77.6	43	14.8	84.5	4	8.1	70.1
	Cass	4	19	11.9	66.2	24	13.5	77.5	16	9.6	58.7
	Cedar	4	17	10.6		30	13.9		6	7.2	
	Chariton	5	17	11.7	75.8	28	16.2	79.1	10	8.3	72.4
	Christian	2	12	13.3	78.9	15	13.5	83.0	8	13.1	74.9
	Clay	1	29	8.8							

Table showing mean analyses and maxima and minima of the beets examined in the chemical laboratory of the United States Department of Agriculture during 1897, arranged alphabetically by States and counties—Continued.

State.	County.	Number of samples.	Averages.			Maxima.			Minima.		
			Weight.	Sugar in the beet.	Purity coefficient	Weight.	Sugar in the beet.	Purity coefficient	Weight.	Sugar in the beet.	Purity coefficient
			Ounces.	*Per cent.*		*Ounces.*	*Per cent.*		*Ounces.*	*Per cent.*	
Missouri	Clinton	1	24	8.8							
	Cooper	21	16	10.0	72.1	39	12.8	77.0	2	7.0	68.6
	Crawford	2	9	11.3		10	11.9		8	10.7	
	Dade	2	14	13.1		17	13.6		11	12.6	
	Dallas	2	10	11.9		10	12.3		10	11.4	
	Daviess	2	21	14.8	78.0	26	15.9	82.3	15	13.6	73.7
	Dekalb	4	31	10.6	69.6	45	11.6	72.5	12	9.9	65.6
	Douglas	3	8	15.3	79.4	10	17.1	83.2	4	13.2	77.1
	Franklin	6	23	12.8	72.5	37	17.2	83.2	12	9.8	68.7
	Gasconade	10	23	11.0	72.4	31	15.5	78.5	16	7.0	65.9
	Gentry	5	28	12.3	73.2	64	14.7	79.0	13	10.4	69.1
	Greeley	1	12	3.6							
	Greene	8	17	11.3	73.2	28	16.7	83.7	8	7.6	57.8
	Grundy	3	23	11.0	72.3	28	11.8	73.0	17	10.2	71.3
	Harrison	4	12	14.5	77.9	17	16.4	84.2	5	12.3	74.2
	Henry	8	18	11.9	71.5	37	17.9	74.1	3	8.9	69.3
	Hickory	1	20	11.4	70.9						
	Holt	8	31	12.3	79.1	54	14.3	83.7	17	8.7	74.0
	Howard	3	16	11.8		26	14.9		5	6.7	
	Howell	5	24	11.2	78.9	35	15.3	82.0	16	5.7	75.8
	Iron	1	3	14.8							
	Jackson	1	38	10.7	70.2						
	Jasper	3	33	12.1		38	14.3		28	10.7	
	Jefferson	6	16	12.3	75.0	24	14.4	79.9	10	10.9	72.6
	Knox	1	36	10.3	67.9						
	Laclede	3	10	12.0		20	12.4		4	11.3	
	Lafayette	6	29	11.6	74.5	50	14.1	80.0	10	9.6	68.3
	Lawrence	10	18	10.2	72.5	26	14.2	79.1	11	6.2	63.2
	Lewis	1	20	10.5	65.1						
	Lincoln	2	14	11.8	72.5	14	12.5	76.6	13	11.2	68.3
	Linn	3	15	12.9	74.8	18	15.2	75.0	12	11.0	74.7
	McDonald	1	21	13.3	85.3						
	Macon	1	10	14.2	72.3						
	Marion	2	15	10.0		15	11.4		15	8.5	
	Mercer	1	44	11.5	75.5						
	Miller	2	17	12.5	71.3	17	15.4	82.2	17	9.7	60.4
	Moniteau	1	10	12.1	74.3						
	Monroe	3	19	12.0	69.8	20	13.1	71.1	17	10.8	68.5
	Montgomery	8	16	8.8	69.2	26	11.4	75.4	9	3.6	59.5
	Morgan	1	11	9.3							

	New Madrid	4	16	11.3	74.3	28	11.8	74.7	6	10.7	73.8
	Newton	7	15	12.7	74.3	20	19.8	78.8	2	10.0	68.7
	Nodaway	6	30	11.1	72.7	47	15.9	77.4	18	8.0	65.1
	Ozark	1	4	13.3	.....	.....	.....	.....	.....	.....	.....
	Perry	1	22	9.8	73.6	.....	.....	.....	.....	.....	.....
	Pettis	5	20	10.8	71.6	27	12.9	74.2	14	8.4	68.7
	Phelps	3	9	14.0	.....	11	15.4	.....	8	13.2	.....
	Pike	6	22	12.1	68.7	56	14.4	76.3	3	10.2	60.9
	Platte	5	31	10.3	71.2	44	11.3	74.0	16	8.6	66.3
	Polk	2	24	12.4	76.9	27	13.2	79.3	20	11.5	74.5
	Pulaski	1	12	18.3	86.1	.....	.....	.....	.....	.....	.....
	Putnam	2	6	14.6	.....	6	15.9	.....	6	13.4	.....
	Ralls	1	21	8.1	.....	.....	.....	.....	.....	.....	.....
	Ray	1	34	10.5	68.3	.....	.....	.....	.....	.....	.....
	St. Charles	4	19	11.9	76.1	29	14.4	77.1	15	10.3	75.0
	St. Clair	6	13	12.8	74.2	24	17.4	76.0	6	9.0	72.0
	St. François	1	11	11.8	67.7	.....	.....	.....	.....	.....	.....
	St. Louis	5	20	10.4	.....	43	15.7	.....	5	6.6	.....
	Saline	7	23	11.5	74.2	47	12.7	77.5	13	10.6	69.3
	Schuyler	1	13	13.2	72.6	.....	.....	.....	.....	.....	.....
	Scotland	1	19	14.3	75.8	.....	.....	.....	.....	.....	.....
	Scott	2	9	11.3	.....	9	13.3	.....	9	9.2	.....
	Shannon	2	9	12.0	.....	9	13.1	.....	9	10.9	.....
	Shelby	4	18	11.5	67.5	30	15.5	69.3	10	8.3	65.7
	Texas	2	15	12.4	70.3	20	12.8	71.2	10	12.0	69.4
	Vernon	4	21	11.0	66.1	26	12.7	72.6	13	8.1	58.7
	Warren	5	20	11.4	75.7	25	15.2	83.2	13	9.4	71.1
	Wayne	2	23	11.1	.....	29	11.4	.....	17	10.7	.....
	Webster	3	17	10.4	.....	31	12.0	.....	9	8.9	.....
	Wright	3	18	15.7	77.8	20	17.0	80.6	16	13.4	74.9
Averages, etc		324	20	11.7	73.5	64	19.8	86.3	2	3.6	57.8
Montana	Dawson	1	12	13.8	79.7	.....	.....	.....	.....	.....	.....
	Gallatin	1	29	13.1	77.1	.....	.....	.....	.....	.....	.....
	Lewis and Clarke	1	15	18.6	81.6	.....	.....	.....	.....	.....	.....
	Yellowstone	1	25	11.9	72.8	.....	.....	.....	.....	.....	.....
Averages, etc		4	20	14.4	77.8	29	18.6	81.6	12	11.9	72.8
Nebraska	Cheyenne	2	13	15.7	.....	14	17.3	.....	12	14.0	.....
	Dakota	1	37	17.0	80.2	.....	.....	.....	.....	.....	.....
	Lancaster	2	20	11.9	74.4	20	13.1	75.7	20	10.6	73.0
	Nemaha	3	32	12.7	76.4	33	13.3	78.5	32	12.2	74.0
	Pawnee	2	51	8.8	.....	58	9.1	.....	43	8.5	.....
	Richardson	1	17	15.0	78.2	.....	.....	.....	.....	.....	.....
	Saunders	1	25	12.7	76.9	.....	.....	.....	.....	.....	.....
	Washington	1	34	13.0	78.6	.....	.....	.....	.....	.....	.....
Averages, etc		13	29	12.9	76.9	58	17.3	80.2	12	8.5	72.8

Table showing mean analyses and maxima and minima of the beets examined in the chemical laboratory of the United States Department of Agriculture during 1897, arranged alphabetically by States and counties—Continued.

State.	County.	Number of samples.	Averages.			Maxima.			Minima.		
			Weight.	Sugar in the beet.	Purity coefficient	Weight.	Sugar in the beet.	Purity coefficient	Weight.	Sugar in the beet.	Purity coefficient
			Ounces.	*Per cent.*		*Ounces.*	*Per cent.*		*Ounces.*	*Per cent.*	
Nevada	Esmeralda	2	25	17.5	81.1	27	17.6	81.8	22	17.3	80.4
	Humboldt	10	21	18.8	83.1	34	20.8	84.5	8	16.3	82.2
	Lander	1	10	20.3	85.5	.....	.....	.....	.....	.....	.....
	Lyon	3	19	17.6	79.6	20	18.0	80.1	19	16.9	79.0
	Washoe	4	10	18.2	.....	15	20.0	.....	4	17.1	.....
	White Pine	1	8	16.0	75.4	.....	.....	.....	.....	.....	.....
Averages, etc		21	18	18.3	81.4	34	20.8	85.5	4	16.0	75.4
New Jersey	Atlantic	2	24	14.8	81.9	38	17.6	87.2	10	12.0	76.5
	Burlington	1	17	18.7	83.7	.....	.....	.....	.....	.....	.....
	Camden	2	22	12.9	80.0	28	14.1	82.2	16	11.6	77.7
	Cumberland	2	9	15.8	.....	9	16.2	.....	9	15.4	.....
	Essex	7	17	13.3	79.2	22	14.9	83.0	14	9.8	67.8
	Mercer	7	20	11.5	79.3	34	13.6	83.1	13	8.6	76.2
	Ocean	8	8	16.4	86.3	11	18.5	90.1	5	12.6	82.5
	Warren	2	20	14.9	87.6	24	15.6	88.6	16	14.2	86.6
Averages, etc		31	16	14.2	81.4	38	18.7	90.1	5	8.6	67.8
New Mexico	Mora	3	13	17.2	82.0	14	18.5	86.2	11	16.5	78.2
New York	Albany	2	19	14.0	.....	19	16.0	.....	19	12.0	.....
	Broome	4	22	15.1	82.8	29	16.1	87.1	15	12.8	76.6
	Cattaraugus	15	18	15.1	81.9	28	17.6	86.7	8	11.8	73.0
	Chautauqua	45	21	16.6	82.7	48	20.0	86.2	10	10.2	75.0
	Chenango	3	16	15.4	78.7	20	15.5	83.8	13	15.3	70.8
	Columbia	1	20	14.7	81.5	.....	.....	.....	.....	.....	.....
	Dutchess	4	16	17.3	85.1	18	22.6	89.1	13	14.5	82.7
	Erie	37	19	15.9	83.9	39	19.2	90.6	5	9.7	66.6
	Fulton	2	24	15.4	83.6	26	16.6	84.4	21	14.1	82.7
	Herkimer	1	16	16.5	78.9	.....	.....	.....	.....	.....	.....
	Lewis	2	21	13.9	77.8	22	14.3	79.4	20	13.4	76.2
	Livingston	3	20	16.8	79.8	25	18.2	83.9	16	14.4	76.7
	Madison	3	14	17.3	78.1	20	20.2	81.3	8	15.0	74.8
	Monroe	3	23	13.1	79.8	27	15.9	85.2	21	13.1	72.7
	Niagara	9	28	14.5	81.9	38	16.6	88.7	16	12.1	76.6
	Oneida	22	14	13.6	81.8	67	17.2	88.2	6	9.7	71.2
	Onondaga	7	17	17.5	83.2	25	19.5	86.4	9	15.5	82.1
	Ontario	22	17	15.0	83.4	20	16.8	87.8	13	12.5	73.5

	Orleans	3	27	16.7	85.4	34	17.5	86.7	16	15.2	84.5
	Otsego	3	24	13.2	80.9	37	14.8	82.1	17	11.3	78.8
	St. Lawrence	3	34	13.1	.....	30	15.9	.....	30	11.1	.....
	Schuyler	1	25	13.8	82.4	.....	.....	.....	.....	.....	.....
	Steuben	2	24	17.0	85.5	24	17.3	85.7	24	16.7	85.3
	Suffolk	1	24	16.9	83.0	.....	.....	.....	.....	.....	.....
	Wayne	8	23	14.5	81.2	39	17.5	87.2	13	13.5	77.5
	Westchester	4	10	12.1	.....	16	13.9	.....	7	10.0	.....
	Yates	15	23	12.7	79.6	50	17.1	88.6	8	9.0	73.2
Averages, etc		225	21	15.0	82.4	67	22.6	90.6	5	9.0	70.8
North Carolina	Cherokee	2	36	7.1	.....	36	7.6	.....	29	6.5	.....
	Davidson	2	18	8.3	.....	20	9.2	.....	15	7.4	.....
	Mecklenburg	1	20	11.9	.....	.....	.....	.....	.....	.....	.....
	New Hanover	1	17	10.2	72.8	.....	.....	.....	.....	.....	.....
	Rowan	1	27	10.6	77.7	.....	.....	.....	.....	.....	.....
Averages, etc		7	23	9.1	75.3	36	11.9	77.7	15	6.5	72.8
North Dakota	Benson	1	17	10.8	.....	.....	.....	.....	.....	.....	.....
	Pembina	1	39	10.6	.....	.....	.....	.....	.....	.....	.....
	Richland	1	30	11.6	81.2	.....	.....	.....	.....	.....	.....
	Walsh	1	26	9.1	.....	.....	.....	.....	.....	.....	.....
Averages, etc		4	28	10.5	.....	39	11.6	.....	17	9.1	.....
Ohio	Allen	1	33	13.3	74.8	.....	.....	.....	.....	.....	.....
	Auglaize	1	16	7.4	.....	.....	.....	.....	.....	.....	.....
	Ashtabula	4	24	15.3	84.1	33	16.2	87.6	17	13.9	78.5
	Brown	2	21	11.9	71.4	23	13.5	73.5	19	10.3	69.2
	Champaign	2	21	13.9	79.7	22	14.3	80.2	20	13.5	79.2
	Clark	2	14	13.2	.....	18	16.0	.....	10	10.4	.....
	Defiance	1	14	17.0	86.4	.....	.....	.....	.....	.....	.....
	Delaware	1	33	14.7	80.6	.....	.....	.....	.....	.....	.....
	Fairfield	2	33	13.2	75.9	48	13.9	76.8	18	12.5	74.9
	Fayette	1	24	15.4	80.9	.....	.....	.....	.....	.....	.....
	Fulton	4	23	13.8	83.7	26	16.0	85.3	16	8.9	81.6
	Greene	1	32	11.3	76.6	.....	.....	.....	.....	.....	.....
	Hardin	3	17	14.3	81.9	20	15.6	84.5	14	13.4	78.4
	Henry	1	16	16.2	78.3	.....	.....	.....	.....	.....	.....
	Hocking	2	19	13.1	75.3	20	13.9	77.2	17	12.3	73.3
	Jefferson	1	12	17.7	79.1	.....	.....	.....	.....	.....	.....
	Licking	2	13	13.3	81.7	16	13.5	82.0	10	13.0	81.4
	Lucas	1	22	16.0	82.0	.....	.....	.....	.....	.....	.....
	Morrow	2	36	14.5	71.1	49	16.6	79.0	23	12.4	63.1
	Ottawa	1	29	5.6	.....	.....	.....	.....	.....	.....	.....
	Paulding	10	24	13.1	76.5	63	17.3	85.3	9	9.5	65.4
	Preble	1	12	13.3	.....	.....	.....	.....	.....	.....	.....
	Putnam	1	16	12.3	80.6	.....	.....	.....	.....	.....	.....
	Seneca	1	19	17.0	81.7	.....	.....	.....	.....	.....	.....
	Shelby	1	43	14.5	79.6	.....	.....	.....	.....	.....	.....

Table showing mean analyses and maxima and minima of the beets examined in the chemical laboratory of the United States Department of Agriculture during 1897, arranged alphabetically by States and counties—Continued.

State.	County.	Number of samples.	Averages.			Maxima.			Minima.		
			Weight.	Sugar in the beet.	Purity coefficient	Weight.	Sugar in the beet.	Purity coefficient	Weight.	Sugar in the beet.	Purity coefficient
			Ounces.	*Per cent.*		*Ounces.*	*Per cent.*		*Ounces.*	*Per cent.*	
Ohio	Stark	3	23	14.9	.....	39	16.3	.....	12	14.2	.....
	Summit	2	20	13.4	73.8	24	16.0	84.4	15	10.8	63.1
	Trumbull	1	19	15.0	79.3	.....	.....	.....	.....	.....	.....
	Van Wert	1	25	11.0	70.6	.....	.....	.....	.....	.....	.....
	Washington	2	40	11.8	77.7	40	12.8	82.7	39	10.7	72.7
	Wayne	8	16	14.7	83.2	26	17.9	89.9	9	12.0	77.8
	Wood	2	18	15.7	78.5	20	18.7	79.5	15	12.6	77.4
Averages, etc		68	22	13.8	79.1	43	17.7	86.4	12	7.4	70.6
Oklahoma	Woodward	1	10	11.8	72.5	.....	.....	.....	.....	.....	.....
Pennsylvania	Allegheny	13	18	13.8	77.0	25	18.4	86.2	10	7.1	72.3
	Crawford	3	25	13.9	75.3	33	17.0	78.7	19	12.3	72.9
	Cumberland	22	12	12.2	79.6	20	17.3	89.2	6	8.6	65.0
	Elk	2	16	13.0	77.4	17	13.5	78.5	16	12.5	76.3
	Erie	7	28	15.8	82.5	45	17.8	86.5	13	13.5	77.3
	Lawrence	2	16	16.8	79.9	19	17.6	80.4	14	16.1	79.3
	Lebanon	1	24	14.4	79.0	.....	.....	.....	.....	.....	.....
	Mercer	2	34	15.4	83.7	34	15.6	84.6	34	15.1	82.8
	Perry	2	31	15.7	82.2	40	17.3	85.3	22	14.1	79.1
	Potter	1	18	18.0	81.1	.....	.....	.....	.....	.....	.....
	Union	1	10	19.6	.....	.....	.....	.....	.....	.....	.....
	York	3	25	13.9	80.2	43	14.5	82.7	16	13.7	77.4
Averages, etc		59	18	13.8	79.5	45	19.6	89.2	6	7.1	65.0
Rhode Island	Washington	2	21	11.9	74.2	23	12.3	76.7	18	11.4	71.6
South Carolina	Abbeville	1	13	9.3	.....	.....	.....	.....	.....	.....	.....
	Berkeley	1	21	7.5	.....	.....	.....	.....	.....	.....	.....
	Charleston	3	29	9.4	.....	31	8.0	.....	10	3.8	.....
	Edgefield	1	15	11.4	.....	.....	.....	.....	.....	.....	.....
	Greenville	2	21	12.6	.....	25	13.1	.....	17	12.0	.....
	Lexington	1	16	7.4	.....	.....	.....	.....	.....	.....	.....
	Pickens	2	16	13.5	.....	22	13.7	.....	10	13.3	.....
	Sumter	2	12	11.2	.....	12	11.5	.....	12	10.9	.....
Averages, etc		13	17	9.9	79.9	31	13.7	.....	10	3.8	.....

South Dakota	Beadle	1	19	14.3							
	Lincoln	1	14	13.4	80.0						
	Meade	1	12	15.1							
	Yankton	2	20	16.5	85.3	22	17.5	87.6	18	15.4	83.0
Averages, etc		5	17	15.1	83.2	22	17.5	87.6	12	13.4	80.0
Tennessee	Knox	8	4	12.1		7	13.5		1	10.6	
	Maury	4	16	11.5	72.6	24	14.9	74.1	10	8.9	69.8
	Warren	2	24	9.5		28	10.6		20	8.3	
	Washington	1	10	10.9	72.6						
	Weakley	2	20	5.7							
Averages, etc		17	11	10.8	71.9	28	14.9	74.1	1	8.3	69.8
Texas	Denton	1	9	13.5							
	Erath	1	47	11.1							
	Grayson	1	28	13.0	80.1						
	Hopkins	1	12	8.8							
	Hunt	1	6	13.4							
	McLennan	1	5	13.0							
	Reeves	4	30	13.6	76.7	33	14.7	79.8	14	11.3	75.1
	Wise	1	13	11.5	72.3						
Averages, etc		11	22	12.6	76.5	33	14.7	79.8	5	8.8	72.3
Utah	Boxelder	3	25	11.7	78.4	27	13.4	81.4	22	10.2	73.1
	Cache	3	17	11.6	78.8	24	15.3	80.0	10	9.1	77.5
	Davis	3	20	14.0	83.0	26	16.2	85.4	15	10.8	80.2
	Sanpete	13	21	14.5	81.0	43	16.6	88.2	10	11.1	77.3
	Sevier	4	16	14.9	78.8	21	16.1	82.0	10	12.9	74.3
	Utah	6	14	16.7	84.8	16	20.2	90.5	11	13.5	79.2
	Weber	3	29	13.1	79.3	36	14.9	85.3	16	10.3	70.6
Averages, etc		35	20	14.3	81.1	43	20.2	90.5	10	9.1	70.6
Vermont	Addison	1	47	10.0							
	Caledonia	1	29	16.9	85.0						
	Chittenden	1	9	16.3	86.3						
	Franklin	1	10	12.7	79.3						
	Lamoille	1	30	13.2	81.8						
	Windham	3	16	14.7	85.5	24	15.9	86.9	11	14.0	83.3
Averages, etc		8	22	14.2	84.1	47	16.9	86.9	9	10.0	79.3
Virginia	Albermarle	1	10	9.7	65.4						
	Appomattox	2	11	11.2		11	14.3		10	8.1	
	Augusta	2	17	10.6		20	13.6		13	7.5	
	Bedford	2	34	6.5		48	7.4		20	5.6	
	Caroline	2	32	11.1	77.2	40	12.2	82.6	24	9.9	71.7
	Carroll	1	15	15.4							
	Charles City	1	19	12.2	77.6						

Table showing mean analyses and maxima and minima of the beets examined in the chemical laboratory of the United States Department of Agriculture during 1897, arranged alphabetically by States and counties—Continued.

State.	County.	Number of samples.	Averages.			Maxima.			Minima.		
			Weight.	Sugar in the beet.	Purity coefficient	Weight.	Sugar in the beet.	Purity coefficient	Weight.	Sugar in the beet.	Purity coefficient
			Ounces.	*Per cent.*		*Ounces.*	*Per cent.*		*Ounces.*	*Per cent.*	
Virginia	Fairfax	2	25	12.4	79.9	31	12.4	83.3	19	12.4	76.5
	Fluvanna	1	19	11.1	78.5						
	Goochland	2	14	13.7	75.4	14	14.0	75.8	13	13.4	74.9
	Hanover	1	23	13.1	73.3						
	Henrico	1	24	6.7							
	James City	1	24	12.4	81.8						
	King William	1	13	13.7	80.9						
	Loudoun	1	7	15.4	72.7						
	New Kent	1	13	12.3	73.3						
	Northampton	4	20	11.6	77.5	26	12.5	79.4	16	10.9	76.2
	Orange	1	21	15.5	76.4						
	Princess Anne	1	19	11.5	78.9						
	Warren	5	31	10.9	73.0	49	14.7	76.5	22	6.3	69.2
	Wythe	1	2	12.2							
Averages, etc.		34	21	11.6	76.2	49	15.5	83.3	2	6.3	65.4
Washington	Chehalis	4	48	7.9		66	9.8		36	5.8	
	Clarke	1	23	13.5							
	King	2	25	11.8	81.1	32	11.9	83.0	17	11.6	79.1
	Kitsap	1	58	11.0	76.2						
	Lincoln	5	18	14.6	74.0	25	19.9	81.0	9	9.1	67.0
	Pierce	1	33	13.0	81.4						
	San Juan	1	18	14.4	78.3						
	Skagit	6	26	12.7	76.4	48	15.3	83.4	16	9.9	74.3
	Whatcom	2	23	11.3	77.5	25	12.9	83.3	20	9.6	71.6
	Yakima	11	24	17.0	87.0	33	19.1	89.7	13	15.0	84.5
Averages, etc.		34	27	13.7	80.7	66	19.9	89.7	9	5.8	67.0
West Virginia	Grant	1	53	13.5	83.0						
	Hardy	1	20	11.9	69.1						
	Monroe	9	18	16.6	81.8	30	18.9	88.8	6	13.6	75.3
	Morgan	2	8	14.		8	14.5		7	14.1	
	Summers	1	16	12.3	78.2						
Averages, etc.		14	19	15.4	80.4	53	18.9	88.8	6	11.9	69.1
Wisconsin	Ashland	1	20	12.7	75.2						
	Clark	1	14	13.9	85.4						

	Dane	31	11	16.4	84.8	21	19.5	88.2	5	13.4	80.5
	Fond du Lac	1	34	12.7	78.7	.....	.....	.....	.....	.....	.....
	Monroe	1	32	11.5	71.4	.....	.....	.....	.....	.....	.....
	Outagamie	1	8	17.2	86.9	.....	.....	.....	.....	.....	.....
	Racine	3	34	15.4	82.6	38	15.9	83.9	29	15.0	80.9
	Rock	1	20	13.2	73.6	.....	.....	.....	.....	.....	.....
Averages, etc		42	15	15.8	83.3	38	19.5	86.9	5	11.5	71.4
Wyoming	Albany	5	12	18.7	86.7	26	22.3	92.1	6	12.2	77.3
	Bighorn	6	20	18.7	82.2	26	22.7	87.2	13	12.0	70.2
	Converse	9	26	17.8	82.2	60	24.3	86.3	12	15.6	77.7
	Crook	1	5	17.1	.....	.....	.....	.....	.....	.....	.....
	Fremont	1	24	12.5	72.0	.....	.....	.....	.....	.....	.....
	Johnson	3	26	11.3	76.1	33	13.4	76.9	14	9.1	75.2
	Laramie	4	17	16.0	83.3	24	17.1	86.9	9	14.7	79.5
	Natrona	2	11	18.5	.....	13	19.6	.....	8	17.3	.....
	Sheridan	3	12	17.9	.....	13	19.6	.....	9	16.2	.....
Averages, etc		34	19	17.2	82.3	60	24.3	92.1	5	9.1	70.2

STUDY OF THE ANALYTICAL DATA.

In further elucidation of the data contained in the preceding tables a brief discussion of them for each State is appended, supplemented by a summary of those secured by the experiment stations in the several States.

ARIZONA.

The samples from Arizona consist of one from Apache County, and six from the agricultural experiment station in Pima County. In the foregoing tables the averages of weight are given to the nearest ounce to avoid the fractions of an ounce, which would necessarily increase the space required for printing. Inasmuch as the weight of the cut beet is so easily varied by a slight difference of the position of the knife in cutting, it is evident that this method of estimation is practically sufficient.

In the analytical data obtained from Arizona, as will be seen by referring to the preceding data, the mean weight of the beets examined was 23 ounces and the mean percentage of sugar in the samples 9.3. On account of the poor quality of the beets, the purity of the juices was not determined. The highest observed percentage of sugar in the beet was 12 and the lowest 7.6.

The following report of his investigations and observations in regard to the sugar beets grown in Arizona, during the season of 1897, was made by Robert H. Forbes, chemist of the Agricultural Experiment Station of Arizona.

RESULTS OF EXPERIMENTS WITH SUGAR BEETS IN ARIZONA FOR 1897.

By R. H. FORBES, Chemist.

Briefly stated, the average for 157 analyses of beets from all over the Territory is 8.56 per cent of sugar in the juice, with a purity of 61.8. At first glance these are discouraging figures indeed, but taken as they stand they are misleading, and their true significance can only be gotten at by examining the whole series of analyses for differences due to the effect of such important factors as care and skill in growing, different kinds of soil, differences of climate found in various localities and at different times of the year, and the variety of beets planted.

In order to show the results of careful cultivation upon the quality of the beets, I have divided the samples received from Salt River Valley into three lots.

The first lot consists of 13 samples grown by Dr. Claflin on the experimental substation grounds near Phœnix. These beets were given the most excellent care. The second lot consists of 24 samples obtained from 12 growers near Phœnix, Glendale, and Mesa. These beets received a fair amount of care during growth, but on the average were probably not as carefully attended to as Dr. Claflin's 13 samples. The third lot consists of 60 samples from the same localities, but which were cared for scarcely at all excepting for an occasional irrigation. The results speak for themselves. Dr. Claflin's 13 samples averaged 11.23 per cent of sugar in the juice with a purity of 68.3. The 24 cultivated samples from other growers averaged 9.42 per cent of sugar in the juice, with a purity of 66.3. The 60 neglected samples gave 8.35 per cent of sugar in the juice, with a purity of 53.4.

These figures confirm the well-known fact that intelligent and skillful care is essential in beet culture; more so, I dare say, than in the production of any other great staple, and careless or ignorant treatment of our vegetable thoroughbred will

inevitably end in disaster. The sugar beet is no exception to the well-known rule that plants, which have been developed through cultivation, if neglected or allowed to run wild, quickly return to their former primitive condition.

Because of the unusual facility with which the sugar beet returns to its former unprofitable condition, it is evident that beet culture is a high art, and in this country the more intelligence is required in its treatment because the conditions are in many ways unusual, and the rules which are successfully applied in other countries must be changed or modified here.

In a general way, however, we may insist that deep and thorough preparation of the soil, careful irrigation, and repeated cultivations and hoeings as long as the crop will permit are no less essential here than elsewhere.

The effect of climate is also perceptible in our analyses. Samples have been received from St. Johns, St. Joseph, Holbrook, Duncan, Buckeye, Thatcher, Skull Valley, Tombstone, Taylor, Fort Thomas, and other more elevated or more northerly points. Almost without exception, the beets from these places were much above the average in richness and purity. The richest samples we have as yet received came from St. Joseph and contained 16.3 per cent of sugar in the juice, with a purity of 81; 17 samples received from the above places averaged 12.37 per cent of sugar in the juice, with a purity of 75.5.

In order to make the comparison more rigid, we select the Kleinwanzlebener variety only from among them, and find that 7 samples average 12.4 per cent sugar, with a purity of 76.3, as against 10.22 per cent sugar and a purity of 67.82 for this same variety in Salt River Valley.

Knowing the great influence of temperature upon the composition of the beet, it is difficult to lay these differences to any other cause than the cooler temperature of these higher and more northerly localities.

It is a matter of regret that arable land is so scarce in these parts of the Territory. Our observations, however, may guide us in obtaining better results in warmer localities, and in this way: Most of the Salt River Valley plantings were made in March and April, so that almost from the start the plants were subject to the hot summer weather, the temperature throughout the months of June, July, August, and September being much above the point generally regarded as most favorable to sugar beets. Now, it is possible that by planting earlier in the year a cooler temperature may be secured for the first three or four months of the life of the plants. Of course the risk from frost will be increased, but that there is some possibility of success in the plan is suggested by the fact that on June 14 we analyzed a sample of beets from Fowler Brothers, near Phœnix, which gave 15.2 per cent of sugar in the juice, with a purity of 76. The seed for this lot was planted February 12 and the beets were probably not mature.

We can not safely draw conclusions from a single instance, but the high percentage and purity in this extremely early sample are suggestive of the possible advantage in early planting.

Selecting the Kleinwanzlebener beets received from the northern places and comparing them with those obtained from Phœnix, Glendale, Tempe, and Mesa, in the Salt River Valley, we obtain the following results:

Showing effect of climate.	Average weight of beets.	Sugar in juice.	Sugar in beets.	Purity coefficient.
Kleinwanzlebener:	*Ounces.*	*Per cent.*	*Per cent.*	
From more northerly or elevated localities, 14 samples...	18	13.35	12.35	78.8
From Salt River Valley, 18 samples.....	18.2	10.48	9.69	69.5

The average mean monthly temperatures for Phœnix, Prescott, and Fort Thomas during several years past are shown in the following table. Phœnix is in the Salt River Valley, Prescott represents the cooler northern parts of the Territory from

which beets were received, and Fort Thomas is in the fertile, irrigated portion of Graham County, in Southeastern Arizona.

	Mean temperature.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
Phœnix	49	54	61	67	74	82	90	88	80	70	61	55
Prescott	34	38	44	51	59	66	74	72	65	54	42	39
Fort Thomas	47	48	55	61	70	79	86	83	75	62	49	44

Finally, as to the soil, it is much more difficult to trace any connection between the quality of beets produced and the numerous varieties of soil, for which this region is famous and on which they have been grown. Fortunately, however, we have recently completed the analysis of a series of twenty representative Salt River Valley soils and certain general characteristics of the soils of this region have been determined.

From a chemical point of view the following statements may be made about five of the most important soil constituents, viz, potash, lime, nitrogen, phosphoric acid, and humus.

Potash is everywhere present in abundant quantities. We have found from 0.47 to 1.96 per cent in our samples, the lower figure being ample for a fertile soil.

Lime also is present in great sufficiency, the samples showing from 0.57 to 4.2 per cent.

Nitrogen, however, is deficient almost everywhere, the average for the series being 0.048 per cent, and in only two instances rising above 0.10 per cent, which is considered to be a needful amount to insure nitrogen fertility.

This deficiency probably affects the richness of sugar beets less than it does their size. It is well known that an excess of nitrogen produces beets of an enormous size, but of very poor quality. In one instance we received a beet weighing 5 pounds, which had been grown on heavily manured and abundantly irrigated soil. The sample gave only 1.7 per cent of sugar in the juice, with a purity of 23. This result was probably due, in part at least, to excessive nitrogen.

The small average size of the beets received, however, points to a poverty of nitrogen in the soil for this crop. This will hold for other crops as well as beets, and I am told that in one case near here two neighboring orange orchards were planted, one on virgin mesa soil, the other on plowed alfalfa ground. It is stated that the latter orchard has prospered far more than its neighbor. This was doubtless due to the nitrogen which alfalfa and other leguminous crops contribute to the soil. In selecting beet ground, therefore, other things being equal, it would be well in this region to choose that which has previously been in alfalfa.

In support of this view I would state that Dr. Claflin's samples were grown on ground that had previously been in alfalfa, so that his excellent record may have been due in part to this cause.

Phosphoric acid is usually present in sufficiency, though never very abundant. In some cases a serious lack of phosphoric acid has been noted. The average for the valley is 0.13 per cent. It is stated that the effect of phosphoric acid in beet culture is to increase the sugar and hasten maturity. It is supplied to advantage in connection with nitrogen, this combination tending to increase the size of the beets and also maintain their richness.

This desirable combination of nitrogen and phosphoric acid is found in guanos and in bone superphosphates, and it is probable that the application of these fertilizers will, so far as beet culture is concerned, greatly improve the soils of this region. The question of cost, of course, enters here, but it is one which must in any case soon be solved. At Chino, Cal., with an exceedingly fertile soil, the need of commercial fertilizers is already felt, after the lands having been cropped for five or six years.

Barn manure is of value for beets only after other crops have been grown on the land, and the manure thereby thoroughly incorporated with the soil. If applied just before planting the beet seed, it will prove injurious both to the stand of plants and the quality of the product.

Humus, or vegetable matter, is deficient in all arid soils, our own among the number. Humus and lime are valuable largely because they impart better tilling qualities to the soil, give it greater water-holding power, and lessen the tendency to hardness when dry. Humus results from barn manure, and the application of this material with suitable precautions should be beneficial.

As to alkali and its effect upon beets, it may be said that when the plants are once established in thrifty growth they will stand more alkali than most other crops. It has been observed also at Chino that the quality of the beets is not impaired by alkaline ground. It is probable, however, as a matter of opinion, that young plants are injured by the crust formed on the surface of the soil through the action of alkali, and this may account in part for the exceedingly poor stand of plants obtained in most of the experiments this year. Almost without exception, the reports state that the seed did not come up well or that the young plants died. This difficulty may possibly be overcome by planting earlier in the year, by using more and better seed, and by taking more care to keep the surface soil loose during the germination of the seed and the first weeks of plant growth. Salt River Valley is not excessively alkaline; much less so, it is stated, than the Pecos Valley in New Mexico, where beet culture is now attempted.

So much for the result of one season's experimental work. The lessons we have learned are: (1) That here as elsewhere sugar beets must be grown with the utmost care; (2) that the cooler portions of the Territory, so far as observed, produce better beets than the warmer localities, and that experiments should be made as to what early planting will do in these warmer localities; (3) that the Kleinwanzlebener variety, so far as yet known, yields the best results in Arizona; and (4) that the soils of the valley stand in need of nitrogen and organic matter, possibly phosphoric acid also, and that previous occupation of the ground with alfalfa or other means of fertilization should be secured.

Though many of the results are unfavorable, the occasional successes that have been secured show that there is ample reason for a continuance of the work.

If, during the next year, a half dozen first-class farmers of this valley will each put in an acre of Kleinwanzelebener beets early in the year, on ground that has been in alfalfa, and will care for them as they ought to be cared for, I believe that we may have something much more favorable to report on this subject.

Further details of the above experiments with beets are published in Bulletin No. 26 of the Arizona experiment station, issued in December, 1897.

The poor results obtained in Arizona are somewhat surprising, although in general it may be said that the climate of Arizona is too warm for securing the best results. The remarks made by Mr. Forbes in regard to careful culture should be given due consideration. The probabilities are, however, that inasmuch as the beets in Arizona were all grown with irrigation, the application of the water was of such a character as to prevent, in some respects, the development of the highest saccharine content. It may be remarked in general, in regard to the beets grown with irrigation, that much is yet to be learned in regard to the manner of supplying the water, the time at which it is to be applied, and the quantity which is to be used. It would be expected that the ideal conditions of moisture could be secured by irrigation, and yet in practice the results have not been the most encouraging.

This has been true in regard to the growth of beets in Utah and New Mexico under irrigation. There is no factor connected with the sugar-beet industry which is of more practical interest than a careful study of the conditions under which irrigated beets should be grown. The fertile soils of the arid regions are undoubtedly able to produce large crops of beets under irrigation, when the proper conditions are understood. Complaints have also been made in respect of the effects of alkali upon beets in these soils, and also of insect pests. It is important that a study be made of the bacteria, molds, and insect pests of sugar beets, together with the effects of the alkali. After allowing for all these conditions, however, it must be confessed that the Arizona data are somewhat disappointing, and unless great improvement can be made there is little prospect of the industry being established on a secure foundation in that region.

Arkansas.

Arkansas lies so far south of the beet belt as to make a discussion of the possibilities of beet growing in that vicinity unnecessary. Only two samples were received from the State, and as might be expected, these do not show any very favorable qualities. A few general remarks may be made about growing beets in warmer climates than those best suited to obtaining the highest grade of beets, namely:

First, that it is quite possible to get fine harvests of beets with favorable tonnage per acre,

Second, that it is possible to grow beets containing quantities of sugar which would have made them valuable for manufacturing purposes several years ago, before the beet reached its present high state of development, and

Third, that such beets could probably be grown with great profit for stock-feeding purposes in all these localities. The full value of the beet and beet pulp will be discussed in a separate portion of this report.

The average weight of the two samples received from Arkansas was 18 ounces, and the average content of sugar in the beet 11.3 per cent.

California.

California is recognized as the principal beet sugar producing State in the Union. Only one sample of beets was received from this State, and it had a weight of 26 ounces and contained 16.8 per cent of sugar. All of the coast valleys of California are favorably situated, in respect of temperature, for the production of sugar beets, and the same may be said of certain lands, the limits of which are not yet well defined, in other parts of the State. Even in the Sacramento Valley, as far inland as the point of junction with the San Joaquin River, where the temperature is higher than that considered best for beets, it has been found that good beets can be grown. In experiments conducted on Union Island, near Stockton, Cal., during the years 1884–85, under direction of the chief chemist of the Department of Agriculture, very

encouraging results were obtained, both in the quantity and the character of the beets produced. These beets were grown upon the reclaimed lands of the delta of the San Joaquin at its junction with the Sacramento River. The lands were protected from overflow by strong levees, but the conditions were not theoretically the most favorable for the production of high-grade beets.

Unfortunately, however, large portions of the coast lands, by reason of their contour, are not well suited to the cultivation of beets. On page 90 of Bulletin No. 5 of the Division of Chemistry, published in 1885, the following observation is made: "In the interior and eastern divisions of California only the high Sierra regions have a temperature low enough for beets, and in that locality there is no land adapted to beet culture. The beet region of California, therefore, is confined to the coast valleys." This statement may have to be modified to some extent by reason of the data mentioned above from Union Island. These observations are corroborated by the analyses made by Director Hilgard, during 1897, of beets grown in Sacramento County. This locality adjoins Union Island, where the experiments conducted by the Department of Agriculture were made. The average size of the beets examined by Director Hilgard was satisfactory, and the content of sugar in the beets was a little over 16 per cent, with a high purity reaching almost 85 for a whole series of analyses. These data show that in the Sacramento Valley, at least where the temperature is somewhat higher than that regarded as most favorable, beets of fine sugar-producing qualities can be grown. After a careful personal study of the climatic and soil conditions in California, made in 1884, it is stated on page 100 of Bulletin No. 5 of the Division of Chemistry that there are in California about 5,830 square miles of land suitable to beet culture, provided the whole of it could be supplied with a sufficient quantity of water. Even if only one-third of this area should be found eventually fit for the culture of beets, it would be possible for the State of California alone to produce nearly 500,000 tons of beet sugar and still practice a proper rotation of crops. In view of the fact that the beet-sugar industry has been so carefully studied in California, both by the agricultural experiment station and by those engaged in the manufacture of sugar, it is not necessary here to dwell further upon the possibilities of its extension in that State.

Colorado.

The number of samples received from the State of Colorado at the Department of Agriculture was 174. The average weight of the beets received was 20 ounces, the mean percentage of sugar in the beet 13.6, and the mean purity 76.7. The conditions which obtain in Colorado are so different from those of the Eastern States as to warrant a detailed discussion of the data. This, however, in the present condition of affairs, would be somewhat premature. It is advisable to wait until a more thorough agricultural survey of the State be made, under the immediate supervision of the agricultural experiment station. When

the analytical table of the data received from Colorado is consulted, it is seen that most remarkable differences exist in the returns from the different counties. Since in most cases only a very few samples have been received from any given county, it is not fair to make any judgment of the possibilities of any one county from data of so limited a nature. The great variations in altitude in the State, causing sharp differences of temperature, must also be taken into consideration. In addition to this, it is fair to presume that the samples have all been grown under irrigation, and it is impossible, in such data as are collected from the farmers, to determine with any certainty what the proper conduct of the irrigation should be. In general, the data are entirely satisfactory, especially in respect of content of sugar. As regards the mean purity of the juices, the data are somewhat unsatisfactory, since it falls more than three points below the minimum of good beets. This may be due to the great amount of mineral salts which the soils of Colorado contain, and to the well-known property of the sugar beet of absorbing these salts from the soil. For this reason, it may be suggested that in many cases cultivation of the sugar beet could be advantageously practiced, not alone on account of the profit in the beet itself, but because of the improvement in the soil which would result from the extraction of the alkaline materials. Among the counties where the samples have been somewhat numerous and the results most encouraging may be mentioned Boulder, lying to the northwest of Denver and mostly within the favorable thermal area, where the average content of sugar in the beet was over 15, and the purity nearly 81. This most favorable result was obtained with exceptionally large beets, the average weight of which was 31 ounces. This fact makes the data even more valuable and suggestive.

Another county where the data were extremely favorable, although the number of samples was only two, is Delta, a county lying within the theoretical thermal area, and where the average size of the samples was 20 ounces, the average content of sugar over 17, and the purity 80.5.

Another favorable result may be reported from Garfield County, although the average size of the beets is a little low. The mean percentage of sugar in the beets was 16.6, and the purity 83.2. This county also lies mostly in the thermal belt.

In contrast with the above should be cited the returns from Logan County, showing not only small beets, but exceptionally low contents of sugar and purities. Logan County, nevertheless, is contained almost wholly within the thermal belt, which is most favorable to the growth of beets. The poor results obtained must therefore be due to causes which are not made known.

Upon the whole, the data from Colorado are exceedingly encouraging and lead to the belief that there are many parts of that State where, with proper conditions of tillage and irrigation, the sugar beet industry may be established with profit.

In connection with the work done by the Department of Agriculture,

it is interesting to consider the report of the director and chemist of the agricultural experiment station of Colorado at Fort Collins:

BRIEF REPORTS REGARDING SUGAR BEET EXPERIMENTS FOR THE YEAR 1897, AT THE COLORADO STATE AGRICULTURAL COLLEGE.

Chemical section.

The work of the chemical department on sugar beets can be summarized briefly as follows:

We began taking weekly samples on September 2. The varieties represented were Vilmorin, two plots; Kleinwanzlebener, two plots; Leon Brand,[1] one plot; and Imperial, one plot. The amount of sugar in the beets was determined from week to week. We did not find a very rapid increase as the season advanced until the beets approached maturity, when we observed a sudden increase of about 3.5 per cent. Our samples varied greatly in their sugar content, but agreed in indicating that the crop in this country was not sufficiently matured to yield marketable beets before the middle of October. The average of the beets analyzed subsequent to this date, debarring one lot, the most of which were grown under unfavorable conditions, and a few samples which were clearly unmarketable beets, is 14 per cent, the range being from 10 per cent to 18.25 per cent of sugar. The coefficient of purity has ranged from 70 to 89, and has averaged 80.7. We believe the average percentage of sugar given to be high enough, but the coefficient of purity—80.7—is lower than the actual coefficient rather than higher.[2]

Respectfully submitted.

WILLIAM P. HEADDEN,
Station Chemist.

Agricultural section.

(From Report of the Director.)

In a general way it can be said that the results of this season's work are very favorable to the establishment of the beet-sugar industry in Colorado. The following figures are to be judged in the light of the statements that come from all the beet-sugar manufacturing States of the Union, that the season of 1897 was especially unfavorable to the industry. If in this poor year Colorado can make such a good showing, what may we expect of her in ordinary or favorable years?

The above report of the chemist of our Experiment Station gives the figures for the beets raised on the College Farm. But few analyses were made here of beets raised elsewhere, since the failure to get into our new chemical building last fall left the Chemical Department in poor shape for doing much outside work.

Practically all the analyses of Colorado beets not grown at Fort Collins were made in the Chemistry Division of the Department of Agriculture at Washington. It has seemed best to give here merely a summary with reference to our local conditions.

For the purpose of sugar-beet raising Colorado may be divided into five sections:

(1) The valley of the South Platte and its tributaries.

(2) The divide south of Denver, and the plains region where beets are grown without irrigation.

(3) The valley of the Arkansas River.

(4) The valley of the Grand River.

(5) The San Luis Valley.

All these, except the second, use irrigation. There are two features of the raising of sugar beets that require special study—namely, the quality of the beets when they are ripe and the time of the year when they reach that degree of ripeness. The

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[1] This variety is unknown to me.—H. W. W.

[2] It is not clear what is meant by this expression.—H. W. W.

earlier in the season they reach a profitable degree of sugar and purity the longer season the factory will have to manufacture the crop, and the larger the amount of crop that can be handled by a factory of a given size.

Many tests were made of sugar beets dug in September, but only a few showed beets suited for use in sugar making. Nevertheless, the fact that a few samples, even by September 18, exceeded 12 per cent sugar and a purity of 80, shows that when our farmers are more used to growing sugar beets they can bring them to maturity several days, and probably two weeks, earlier than the average crop of 1897. With the first days of October the crops ripened rapidly.

The following table presents a summary of the season of 1897, with reference to the quality of the beets, and the time of ripening in different parts of Colorado:

Section of State.	Samples dug between Oct. 1 and 10.		Samples dug between Oct. 10 and 15.		Samples dug after Oct. 15.	
	Sugar.	Purity coefficient.	Sugar.	Purity coefficient.	Sugar.	Purity coefficient.
	Per cent.		*Per cent.*		*Per cent.*	
The valley of the South Platte	14.1	80.7	14.6	81.1	15.4	81.1
The divide and the plains	12.5	73.7	15.1	80.6	14.8	78.3
The valley of the Arkansas	.....	.....	13.1	77.9	15.3	81.9
The valley of the Grand	16.3	83.6	.....	.....	.....	.....
The San Luis Valley	13.7	79.2	12.4	78.5	14.8	80.3

IDAHO.

The number of samples received at this laboratory from the State of Idaho was only seven, representing two counties. The average weight of the beets received was 21 ounces, the average content of sugar therein 15.5 per cent, and the average purity 79.4. Both in respect of size of the beets and content of sugar the results are very encouraging. The average coefficient of purity is almost up to the minimum standard, and doubtless could be improved later on. The alkalinity of the soil, which has been mentioned in connection with the lowering of the average in Colorado, is doubtless active in Idaho. There are large areas in Idaho where the thermal conditions are favorable, but they are detached from the main thermal belt crossing the continent. There are two centers of thermal conditions in Idaho which serve as nuclei for determining the conditions most favorable. One of these lies almost wholly in the State, and Boise City may be regarded as the center of it, and the other extends into the western and northern part of the State from the State of Washington. In general, it may be said that the thermal conditions in Idaho, if they alone are to be considered, are sufficiently favorable for the culture of the beet, in so far as the growing season is concerned. The data obtained, while meager, are sufficiently encouraging to warrant a more thorough survey of the State, and also the belief that the conditions for the successful establishment of the sugar industry may be found wherever the character of the soil, in respect of contour and fertility, and the facilities for irrigation and other factors favorable to the growth of the sugar beet and the manufacture of sugar can be secured. The report of the chemist of the station contains much valuable information in respect of the sugar-beet industry in the State of Idaho, and is herewith appended:

RESULTS OF EXPERIMENTS IN IDAHO.

In the first place, the results of the past season are quite disappointing and unsatisfactory, due to several causes which will be eliminated largely in the experiments of next year.

The climatic conditions of Idaho are quite varied, the growing season opening several weeks earlier in South Idaho, along the Snake River and in the Boise Basin, than along the Clearwater or in North Idaho. The seed furnished gratis to this station by the Department of Agriculture arrived late, and before it could be distributed—May 4 to June 2—the season was well advanced, hence the seed that was planted either failed of germination, or the young plants were killed by severe climatic changes of heat and drought, or of cold and wet soil, which latter condition prevailed in the Palouse region. Much of the seed sown in our station plats failed to grow. The stand was irregular, weak, and of poor quality, so that the tonnage per acre could not be estimated with any degree of reliability. It is therefore omitted from the tables.

Seed was mailed to 114 farmers, representing 41 different sections of the State, yet samples of beets for analysis were received at this Department from only 20 farmers, representing 13 localities. This apparent apathy on the part of our farmer friends is explainable in part. In many cases the seed did not reach its destination, or when planted it failed to germinate, or the young plants were destroyed by insects or jack rabbits. In a few cases there was not sufficient interest manifested in the experiment to induce proper cultivation of the young plants, therefore no samples worthy of shipment were grown.

Sugar-beet growing is a new industry to the American farmer, and he has yet to learn that the ordinary farm methods are not always applicable and sufficient to grow and mature a typical sugar beet. The Idaho rancher is not an exception. He has yet to learn the value of intensive methods, from the preparation of the seed bed to the marketing of his crop. The neglect to plow deeply, to pulverize finely, to place the seed with care, to thin the plants judiciously, to cut out the weeds, withal to cultivate and hoe the growing plants regularly, resulted in partial or entire failure of the experiment. The sugar beet is a thoroughbred, and must be given care in keeping with its regal characteristics if high sugar content and purity are to be attained. The successful sugar-beet grower has learned that the sucrose is practically hoed into the root. This knowledge and its application our farmers evidently were not in possession of, or the number of samples forwarded would have been greatly augmented. It is a matter of education, however, which will be overcome in time by the dissemination of information through the press, the station bulletin, and closer competition induced by immigration from older States, where better methods of farming prevail.

The 41 samples analyzed averaged in sugar content 15.17 per cent; in purity, 87.55. The 20 samples grown by the Station gave in sugar 15 28 per cent; in purity, 92.55. The 21 samples grown elsewhere averaged 15.07 per cent of sugar, and 82.78 in purity. The highest and lowest results gave 19 and 10.2 per cent in sugar; and 95.10 and 81.81 purity, respectively.

OTHER SUGAR BEET DATA NOT HITHERTO GIVEN TO THE GENERAL PUBLIC.

During the fall of 1894, 192 analyses of sugar beets were made by the Station, which gave an average of 13.7 per cent of sugar and a purity of 76.08 degrees. Some of the samples were large, others had been frozen, still others were immature, while a few varieties were not at all adapted to our soil and climate. This reduced an otherwise much higher average. Excluding about 20 samples, the remainder, 55 samples of Vilmorin's Improved gave an average of 11.77 per cent of sugar and a purity of 75.55 degrees.

Forty-four samples of Kleinwanzlebener beets averaged 14.16 per cent of sugar with a purity of 82.80.

Thirty samples of Imperial averaged in sugar 14.1 per cent, in purity, 85.42.

Ten samples of French Red Top gave an average of 13.65 per cent of sugar with a purity of 82.70.

The average of 10 samples of Lane's was 13.44 per cent of sugar with a purity of 81.69.

Eight samples of New Danish gave an average of 13.83 per cent of sugar and a purity of 81.81.

The highest and lowest percentages of sugar in each variety were as follows:

Variety.	Highest.	Lowest.
	Per cent.	*Per cent.*
Vilmorin's	16.6	14.4
Kleinwanzlebener	19.6	14.6
Mette	18.4	14.6
Imperial	18.2	10.6
Lane's	15.7	10.6
Red Top	15.9	10.7
Danish	15.2	10.8

The places represented in the experiment were the University of Idaho, Cœur d'Alene, Sand Point, Moscow, Kendrick, Lenville, Princeton, Cornwall, Genesee, substation at Grangeville, substation at Idaho Falls, substation at Nampa.

The average yield throughout the State was estimated at 20 tons per acre.[1]

ANALYSES OF BEETS GROWN IN 1895.

The experiments in sugar beets for 1895 were covered by 342 analyses of beets grown by the University of Idaho and by farmers residing near Grangeville, Nampa, Moscow, Weippe, Vollmer, Palouse, Spokane Bridge, Westlake, Starner, Newport, Salmonn, and Paris.

The average sugar content of the crop was 15.19 per cent; coefficient of purity, 79.91. In the analyses were included 15 samples of red or table beets. These 15 contained an average of 13.75 per cent of sugar in the juice and a coefficient of purity of 75.57.

Several analyses were made for the purpose of determining what bearing, if any, the size of the sample beet had upon the sugar content and purity. Among others I select four varieties, and submit the results without comment:

VILMORIN'S IMPROVED.

Size.	Weight.	Sugar in beet.	Purity coefficient.
	Ounces.	*Per cent.*	
1. Large	21.4	14.02	79.96
2. Medium	15.2	14.31	81.26
3. Small	7.8	14.07	78.58

FLORIMOND DESPREZ.

1. Large	28.7	14.35	83.95
2. Medium	16.5	14.46	84.00
3. Small	10.7	14.10	80.25

LANE'S IMPERIAL.

1. Large	24.1	13.62	80.92
2. Medium	13.3	13.69	82.17
3. Small	8.0	13.38	82.07

KLEINWANZLEBENER.

1. Large	26.0	14.00	84.13
2. Medium	17.0	14.06	84.72
3. Small	13.0	13.74	83.93

[1] This estimate, as is usual in such cases, is doubtless too high.—H. W. W.

ANALYSES OF BEETS GROWN IN 1896.

The work of the year was confined very largely to the station, and consisted of a special effort in the way of growing typical sugar beets. The effect of deep and shallow plowing, regular cultivation, fertilization, and irrigation, as compared with the average treatment given the root under natural conditions as to soil, moisture, and cultivation, was noted. The seed bed was prepared and the seed sown from the 21st to the 30th of May. Very heavy rains prevailed on June 5 and again on June 9. All of the seed had germinated by June 11. The average per cent of stand June 5 was 10.7; June 24 it was 29; one month later it had reached 61.8 per cent. The crop was harvested and analyzed during October. The number of analyses made was 60; the per cent of sucrose in juice was 14.18; coefficient of purity, 77.30; yield per acre, 48,510 pounds.

The sugar-beet experiments connected with this station during 1894, 1895, 1896, and the inauguration of the work of 1897 were under the direction and control of the Agricultural Department, the chemist being responsible only for the analytical data. In July, 1897, under the redistribution of the powers of the station staff, the rather unsatisfactory data thus collected were assigned to the chemical department for compilation and publication, together with the power of supervision of such experiments in the future.

METEOROLOGICAL RECORD.

The better to understand the possibilities of the sugar-beet industry in the Palouse country of Idaho, as well as other experiments that may hereafter be undertaken by the station upon the "university farm," the following meteorological data are included in this report. We are under obligations to Prof. J. E. Bonebright, meteorologist of the station, for the results tabulated:

TABLE 11.—*Meteorological record for Moscow.*

Month.	Maximum temperature.	Minimum temperature.	Average temperature.	Humidity.	Rainfall.	Days fair.	Days clear.	Days cloudy.
1894.	°	°	°	*Per cent.*	*Inches.*			
April	76.0	25.0	47.40	76.0	1.38	8	7	15
May	86.0	30.0	57.40	63.0	1.53	7	15	9
June	84.0	32.0	62.00	74.0	1.23	3	19	8
July	93.0	40.0	78.00	65.0	.12	2	29	0
August	96.0	34.0	70.50	46.0	.25	3	26	2
September	85.0	32.0	58.80	72.0	.89	2	25	3
October	74.0	28.0	40.40	85.0	3.70	9	9	13
1895.								
April	76.0	26.0	48.10	70.0	1.30	5	12	13
May	81.0	30.0	51.90	68.0	2.17	2	22	7
June	96.0	33.0	59.40	52.0	.41	.....	.....	.....
July	92.0	41.0	72.70	38.0	.90	1	29	1
August	94.0	33.0	74.50	47.0	.32	3	26	2
September	84.0	28.0	49.80	70.0	3.33	2	20	8
October	74.0	21.0	46.10	72.0	Trace.	2	27	2
1896.								
April	68.0	26.0	42.53	.....	.57	12	10	8
May	84.0	31.0	46.50	85.5	3.60	4	13	14
June	92.0	34.0	61.10	61.7	2.21	0	30	0
July	97.0	14.0	70.41	55.6	.17	0	30	1
August	93.0	38.0	67.17	55.4	1.33	0	26	5
September	85.0	30.0	54.65	72.2	.81	0	22	8
October	76.0	28.0	46.33	.....	1.07	2	17	12
1897.								
April	63.1	36.5	49.70	72.2	.40	0	19	11
May	78.8	38.8	.....	.....	1.20	0	21	10
June	65.6	46.0	53.80	77.4	2.72	0	25	5
July	82.0	48.5	70.00	45.4	.85	0	26	5
August	81.6	46.4	71.50	40.3	.35	0	30	1
September	69.9	38.4	59.20	77.6	1.67	0	22	8
October	66.4	36.4	.....	.....	1.10	3	22	6

Illinois.

The samples received from the State of Illinois by the Department of Agriculture were 32 in number. The average weight of the samples was 17 ounces, percentage of sugar 13.1, and the purity 75.5. Twelve of these samples were from the northern, 8 from the central, and 12 from the southern belt.

When judged by the few samples analyzed by the Department of Agriculture, it is seen that Illinois presents an exception to the established rule, inasmuch as the beets grown in the northern belt are inferior to those grown in the central belt. The data, however, are not numerous enough to base any certain conclusions upon them, and the usual rule is established from the more numerous analyses conducted by the agricultural experiment station, as will be seen farther along. Summarized, the results obtained at the Department of Agriculture from the northern, central, and southern belts in Illinois are as follows:

Summary of analyses of sugar beets from Illinois.

[Compiled from analyses of the United States Department of Agriculture.]

	Number of samples.	Average weight.	Sugar in beets.	Purity coefficient.
		Ounces.	*Per cent.*	
Northern belt	12	19	12.6	76.2
Central belt	8	20	13.8	76.5
Southern belt	12	13	13.2	73.3

At the agricultural experiment station of Illinois, at Urbana, 312 samples of beets were received and analyzed. The following summary shows the analytical data and the distribution of the samples by counties:

Summary of analyses of sugar beets from Illinois, by counties.

County.	Number of samples.	Average weight.	Sugar in beets.	Purity coefficient.	County.	Number of samples.	Average weight.	Sugar in beets.	Purity coefficient.
NORTHERN BELT.		*Ounces.*	*Per ct.*		CENTRAL BELT.		*Ounces.*	*Per ct.*	
Stephenson	1	20	10.7	70.0	Kankakee	8	24	12.9	79.3
Winnebago	2	18	13.4	75.8	Henderson	1	22	9.2	70.8
McHenry	1	19	15.1	84.3	Knox	4	20	11.0	75.1
Carroll	4	20	13.8	81.4	Stark	1	10	14.4	78.3
Whiteside	6	22	13.9	79.2	Peoria	4	24	13.0	80.1
Ogle	3	23	12.6	74.6	Marshall	1	18	14.3	83.9
Lee	8	16	13.8	80.6	Woodford	1	22	13.3	82.1
Dekalb	7	20	13.4	78.3	Livingston	3	17	14.0	82.9
Dupage	1	21	15.6	82.2	Iroquois	50	20	11.3	75.3
Cook	3	24	14.3	82.7	Hancock	1	17	10.6	64.0
Rock Island	1	16	14.9	82.5	Fulton	1	17	11.2	77.1
Henry	6	18	12.7	78.3	Tazewell	2	20	12.3	78.8
Bureau	3	33	10.5	76.5	McLean	5	24	12.0	77.6
Lasalle	31	22	13.1	76.4	Ford	1	24	10.8	77.0
Kendall	2	14	13.8	82.8	Adams	4	17	12.4	75.5
Grundy	1	18	13.9	80.2	Mason	25	19	11.1	75.7
Will	23	28	12.9	74.6	Logan	4	29	9.8	69.6
Mercer	1	17	12.6	79.7	Dewitt	1	27	13.8	81.7

Summary of analyses of sugar beets from Illinois, by counties—Continued.

County.	Number of samples.	Average weight.	Sugar in beets.	Purity coefficient.	County.	Number of samples.	Average weight.	Sugar in beets.	Purity coefficient.
CENTRAL BELT—continued.					CENTRAL BELT—continued.				
		Ounces.	*Per ct.*				*Ounces.*	*Per ct.*	
Macon	1	18	8.0	64.9	Clark	4	11	13.6	73.9
Piatt	2	20	12.7	81.0					
Champaign	10	21	11.7	79.6	SOUTHERN BELT.				
Vermilion	2	19	11.3	75.2					
Pike	1	10	9.6	69.4	Effingham	1	10	12.6	74.6
Scott	1	10	9.7	64.3	Madison	15	21	10.3	74.0
Morgan	4	22	10.3	74.3	Bond	1	18	10.3	80.8
Sangamon	2	17	11.2	76.8	St. Clair	11	21	12.3	77.7
Christian	2	19	11.8	76.5	Washington	1	16	11.9	75.2
Shelby	3	21	10.9	71.9	Jefferson	1	14	12.1	85.0
Douglas	3	24	11.2	77.5	Wayne	1	16	14.3	77.0
Edgar	2	16	12.1	74.9	Clay	1	15	11.8	68.3
Calhoun	2	14	9.4	72.1	Edwards	1	15	8.7	58.7
Greene	3	14	8.5	68.3	Jackson	2	17	10.8	73.8
Macoupin	6	17	11.6	72.2	Saline	3	10	9.3	68.9
Montgomery	5	11	13.0	76.9					

The average weight of the beets received was 20 ounces, the mean percentage of sugar therein 11.9, and the mean purity 76.4. Distributed geographically into northern, central, and southern sections, we find each of the sections represented by the number of samples of the mean average composition indicated in the following summary:

Summary of analyses of sugar beets from Illinois.

[Compiled from the experiment station report.]

	Number of samples.	Average weight.	Sugar in beets.	Purity coefficient.
		Ounces.	*Per cent.*	
Northern belt	104	22	13.2	79.3
Central belt	165	20	11.5	75.4
Southern belt	43	19	11.1	74.7
Average, etc	312	20	11.9	76.4

Here we see the regular rule illustrated, and the beets derived from the northern are superior in every respect to those from the central and southern belts. It is evident, however, judged by the data obtained during the present year, that Illinois is not so well adapted to the growing of high-grade beets as some of the States to the east of it. Nevertheless, it is quite certain that, with proper drainage, scientific cultivation and fertilization, and good culture, high-grade beets can be grown in many of the northern counties of Illinois, and it would probably be safe to say that for a distance of 100 miles from the boundary between Wisconsin and Illinois the sugar-beet industry could be successfully established where the conditions of soil and factors favorable to manufacture are suitable.

INDIANA.

One hundred and three samples were received at the Department of Agriculture from the State of Indiana, representing several different

parts of the State, but mostly from the northern portions. The largest number of samples, however, from any one county was from Vanderburg, in the extreme southwestern part of the State. The average size of the beets from Indiana was small, the percentage of sugar in the beet fair, and the purity a little below the minimum for good beets. In general, the best beets were grown in the northern portion of the State, near or in the thermal beet belt, although a few samples received from the central and eastern parts of the State were very satisfactory. Among the counties furnishing the largest number of samples may be mentioned Henry, in the central eastern part of the State, from which 8 samples were received, having an average weight of 17 ounces, containing 13.1 per cent of sugar, with a purity of 78.5. The averages for Henry County in sugar and purity were almost exactly those for the whole State. Three samples from Marion County, in the central portion of the State, show excellent results, both in percentage of sugar and in purity, and having an average size of a pound. The best results are reported from Stark County, in the northwestern portion of the State, where the percentage of sugar was 15.7 and purity 81.8. The beets, however, from this region were small, the average size being only 12.8 ounces. The beets received from the agricultural experiment station were very much undergrown, the average weight being less than 7 ounces. The percentage of sugar in the beets was good—15.1—and the purity also above the minimum. The causes of the poor yield of beets are discussed farther on in the report of the chemist of the station. The largest number of beets from any one county was received from Vanderburg, namely, 40 samples. The people of this county have been particularly interested in the industry, and especially to Mr. H. Cordes are we indebted for the large number of samples received. In spite of the very fertile soil and other favorable conditions of culture, the beets had an average size of only 14 ounces, and both the percentage of sugar in the beet and the purity were below the minima. In general, it may be said of Indiana that the northern portions of the State, where the character of the soil is favorable, are best suited to the culture of the sugar beet, namely, those portions either lying in the area of favorable thermal conditions, or extending to a varying distance to the south thereof and covering the greater portion of the northern part of the State. The central counties of the State, judged by the few samples received, may also be expected to grow beets of fair quality. A more careful agricultural survey of the State is needed, and the data above are supplemented by the more valuable data collected by the agricultural experiment station under the supervision of the chemist, Mr. H. A. Huston.

NOTES ON SUGAR BEETS RAISED IN INDIANA IN 1897.

(From Report of H. A. Huston.)

The early part of the season was fairly favorable to the growth of the crop. In many cases, however, the beets were planted quite late and were much below normal size when the drought came on in August. From the middle of August until the

end of the usual growing season very little rain fell. This tended to produce beets of high sugar content and small size. The popular interest in the subject has been much greater than in previous years and a much better return than usual was secured from the seed sent out.

At three points in the State parties are now engaged in placing contracts for sufficient acreage to insure a three years' supply of beets for a 300-ton factory. Reports from these localities indicate that the required acreage will be secured.

Nearly all farmers who have raised experimental crops of beets for the past few years report that they believe the crop would be a profitable one at $4 per ton. This estimate is based solely on their own experience with the crop.

The total number of samples analyzed at the agricultural experiment station of Indiana was 205. Arranged by counties, the following table gives the most important data connected with the analyses:

Tests of sugar beets grown in Indiana in 1897 under the direction of the Indiana agricultural experiment station. H. A. Huston and J. M. Barrett.

County.	Average weight.	Average per cent of sugar in juice.	Average purity.	Number of beets by counties.	County.	Average weight.	Average per cent of sugar in juice.	Average purity.	Number of beets by counties.
	Ozs.					*Ozs.*			
Lake	51	8.3	68.0	1	Grant	12	13.6	70.1	2
Porter	12	13.7	84.0	2	Jay	26	13.3	79.5	2
Laporte	22	9.0	64.3	1	Fountain	31	10.1	68.6	1
St. Joseph	24	13.0	85.0	6	Clinton	18	13.2	83.2	4
Elkhart	12	14.8	83.6	7	Boone	13	13.6	82.0	5
Lagrange	12	16.6	87.4	1	Tipton	20	13.5	82.3	11
Starke	14	14.1	85.0	28	Madison	33	9.2	70.2	1
Newton	11	13.7	96.4	1	Randolph	24	12.9	79.0	3
Jasper	2	17.9	84.4	1	Parke	8	10.2	56.7	1
Allen	23	13.5	82.4	21	Marion	17	12.7	83.5	1
Benton	31	11.2	79.6	3	Hancock	23	14.0	87.4	4
White	20	10.3	66.0	1	Henry	19	12.9	78.0	12
Cass	17	12.1	77.2	4	Morgan	14	13.9	82.8	3
Wabash	14	13.0	77.8	4	Greene	12	12.8	84.4	3
Huntington	25	11.8	78.0	19	Jackson	8	10.0	72.8	2
Warren	18	12.2	83.0	1	Vanderburg	15	10.6	77.7	36
Tippecanoe	15	12.5	84.6	8					
Carroll	11	12.4	82.0	5	Averages, etc ...	17.8	12.6	80.7	205

As will be seen above, nearly all the counties represented are in the northern part of the State. Only a few counties are represented in the central and southern portions of the State. Making an average of the results from the different counties by sections of the State, it is seen that they vary considerably, as is shown in the following summary:

Summary of results.

	Average weight.	Average per cent of sugar in juice.	Average purity coefficient.	Number beets.
	Ounces.			
Northern belt	18.9	13.3	81.9	97
Central belt	18.5	12.9	80.7	67
Southern belt	14.2	10.7	78.0	41

It is seen that there are considerable areas in the northern part of the State where both soil and climatic conditions are extremely favorable to the culture of the sugar beet. The proximity of these counties to Chicago insures a market for all the products of the factory. In many cases these counties are situated in or near the gas area of the State, so that fuel is comparatively cheap. All of them are within easy distance of the great coal fields of Indiana, and the supply of water and limestone is abundant. It is evident, therefore, that all the conditions favorable to the growth and manufacture of the beets exist in the northern part of the State of Indiana, and there is no reason to doubt the speedy foundation and healthy growth of the industry in that locality.

IOWA.

The thermal conditions for the growth of beets in Iowa are favorable over almost the whole of the State from north to south. The southern counties are probably a little too warm for the best results, and the northern counties too much exposed to severe cold weather during harvest time.

One hundred and thirty samples of beets were sent directly from Iowa to the Department of Agriculture for analysis.

In the results as tabulated by counties it will be observed that a great many of the counties are represented by a single sample, and therefore it is not possible to base any conclusions on the work done in respect of the possibilities of growth of beets in such counties. Benton County sent 6 samples, with an average weight of 16 ounces; 13.8 per cent of sugar in the beet, with a purity of 76.9. Clinton County furnished 5 samples. The beets were very small, averaging only 11 ounces. The content of sugar was high, namely, 16.8 per cent, and the purity low, 75.8. Greene County sent 39 samples of good size, namely, 21 ounces; rather low content of sugar, namely, 12.7 per cent, and a low purity, namely, 76.3. Guthrie County sent 6 samples of good size, namely, 23 ounces; rather low content of sugar, 12.5 per cent, with a purity of 78.8. The averages for the 130 samples from the State are as follows: Weight, 18 ounces; sugar in beets, 13.3 per cent; purity, 73.7.

Under the direction of the agricultural experiment station of the State, in cooperation with this Department, a large number of samples of seed was distributed, and 642 samples of beets sent to the station for analysis. Following is an abstract of the report of Prof. C. F. Curtiss, director of the Iowa station:

Total number of samples analyzed, 642.

One and seven-tenths per cent of the samples contained 17 per cent or more of sugar; 73 per cent of these had a purity coefficient of 80 or above, and 50 per cent of these samples weighed 14 ounces or above.

Four and three-tenths per cent of the samples contained 16 per cent and over of sugar and less than 17 per cent; of these samples 86 per

cent had a purity coefficient of 80 degrees or above, and 2.9 per cent weighed 14 ounces or above.

Twenty-two and three-tenths per cent of the samples contained 14 per cent or over of sugar and less than 16 per cent; of these samples 50 per cent had a purity coefficient of 80 or above, and 62 per cent weighed 16 ounces or above.

Forty-one and four-tenths per cent of the samples contained 12 per cent and over of sugar and less than 14 per cent; of these samples 14.7 per cent had a purity coefficient of 80 or above, and 69 per cent weighed 16 ounces or above.

Sixty-nine and three-tenths per cent of the total number of samples contained 12 per cent or more of sugar.

The above percentages are based on the weight of the juice.

The mean weight of the samples received at the Iowa station was 19 ounces, the mean percentage of sugar in the beet 12.4, and the mean purity 76.6. The results by counties are given in the following table:

Analyses of sugar beets grown in Iowa and analyzed by the Iowa agricultural experiment station.

County.	Average weight per root.	Sugar.	Purity coefficient.	County.	Average weight per root.	Sugar.	Purity coefficient.
	Ounces.	*Per cent.*			*Ounces.*	*Per cent.*	
Adair	19	13.40	77.45	Johnson	20	12.54	76.98
Adams	21	13.26	75.30	Jones	17	14.05	77.52
Allamakee	20	14.26	78.87	Keokuk	23	14.06	76.46
Appanoose	8	16.11	82.80	Kossuth	25	12.58	77.26
Audubon	16	13.09	78.36	Linn	17	12.08	74.02
Benton	21	13.30	76.68	Louisa	10	12.65	74.54
Blackhawk	17	13.98	79.64	Lyon	19	14.07	79.33
Boone	17	13.33	76.81	Madison	18	12.55	74.34
Bremer	14	11.24	78.71	Marion	21	12.86	74.66
Buchanan	15	14.24	76.25	Marshall	22	12.51	74.85
Buena Vista	19	13.62	77.70	Mills	19	12.94	76.94
Butler	13	10.77	74.45	Mitchell	20	12.37	76.21
Calhoun	12	15.80	81.46	Monona	27	13.86	80.87
Carroll	22	12.34	75.51	Montgomery	25	12.33	76.52
Cass	22	12.03	75.34	Muscatine	20	14.44	80.92
Cedar	21	12.56	74.48	O'Brien	16	14.38	92.77
Cherokee	19	13.34	77.01	Osceola	14	14.16	81.48
Chickasaw	15	13.34	75.54	Page	23	12.56	74.22
Clay	17	12.08	74.06	Palo Alto	22	12.88	106.85
Clayton	23	13.48	78.47	Plymouth	26	12.49	79.39
Clinton	17	15.81	78.97	Pocahontas	20	11.76	78.46
Crawford	23	10.55	68.24	Polk	22	12.96	76.09
Dallas	23	13.46	79.33	Pottawattamie	19	13.04	78.13
Davis	14	15.78	73.94	Poweshiek	20	12.87	77.52
Decatur	12	14.14	79.27	Ringgold	17	12.54	75.58
Delaware	18	13.23	75.76	Scott	16	13.73	76.59
Dickinson	21	12.81	75.16	Shelby	24	13.43	78.58
Dubuque	17	14.14	69.76	Sioux	28	12.44	73.79
Fayette	17	14.62	80.33	Story	22	12.30	76.51
Floyd	24	12.77	75.01	Tama	17	12.55	77.04
Franklin	17	12.62	73.23	Taylor	11	11.82	70.39
Fremont	19	12.15	71.37	Union	15	13.98	76.54
Greene	19	13.04	77.42	Wapello	19	13.70	76.74
Grundy	23	12.00	73.91	Warren	20	13.62	75.79
Guthrie	22	12.60	74.98	Washington	21	13.84	77.84
Hamilton	21	12.58	75.24	Wayne	13	15.15	70.92
Hancock	18	11.92	75.84	Webster	18	12.57	76.14
Hardin	19	12.88	77.01	Winnebago	22	12.21	76.87
Harrison	17	12.65	76.57	Winneshiek	19	13.57	76.42
Henry	26	14.24	78.64	Woodbury	20	12.72	74.34
Howard	18	13.33	77.48	Worth	18	13.34	78.77
Ida	21	12.79	77.49	Wright	15	12.22	75.48
Jasper	23	13.06	76.86				
Jefferson	12	12.36	76.27	Average	19	12.98	76.56

The results contained in the above table are not as satisfactory as would be expected from the location of Iowa in respect of thermal and other climatic influences. The poor results obtained are due either to the seasonal influences, which might have been particularly bad for the season in question, or to some unsuitability of the soil or climate to the production of high-grade beets. In general, it has been observed that soils particularly rich in humus and of a black color do not produce as high-grade beets as sandy and somewhat lighter-colored soils. The character of the subsoil and of the stratum underlying it must also be taken into consideration before we can have an idea of the condition of aeration of the soil and the possibilities of the roots of the beets extending to the proper depth. It is fortunate that the agricultural experiment station of Iowa will continue these experiments in a more careful manner and under more efficient control of the station or some of its representatives. It is evident that with the possible exception of the southern tier of counties a large portion of the State of Iowa with favorable soil conditions should produce beets of high saccharine strength. The causes which have depressed both the content of sugar and the coefficient of purity should be carefully investigated.

Kansas.

Several years ago extensive experiments in growing beets in Kansas were made at Medicine Lodge, and accounts of the work are given in former bulletins on this subject. At that time it was stated, in discussing the results, that the climate of Kansas was particularly unfavorable to beet culture. The extremely dry weather to which much of the State is frequently subjected, in conjunction with the hot winds which sweep over the vast plains almost every year from the southwest, renders the growth of the beet extremely precarious. At times excellent beets can be grown; in fact, beets of fine character were produced at the time mentioned at Medicine Lodge. It is not to be expected, however, that from year to year beets of high grade can be grown in sufficient quantities to warrant the building of factories in the State. Nevertheless, considerable interest is taken in the work by the farmers in various parts of the State, and also by the agricultural college and experiment station. Forty-one samples were received by the Department of Agriculture. The average size of these samples was rather large, namely, 27 ounces. The sugar content was low, 11.4 per cent, and the purity quite low, 73.8. While it is evident that large quantities of sugar can be made from beets of this character, it is also plain, without argument, that such a quality of beets would not be able to compete with those grown in more favorable localities.

The agricultural experiment station of Kansas, in cooperation with the Department of Agriculture, also conducted a series of experiments and received for analysis 157 samples. A detailed report of this work

will be found in the bulletins of the agricultural experiment station of Kansas, and the following summary sufficiently indicates the character of the results obtained. The number of samples analyzed was 157. The average net weight of the beets received was 17 ounces; the average content of sugar in the beets, 11.9 per cent, and the average coefficient of purity of the juice, 77. The percentage of the whole number of beets containing 13 per cent of sucrose or over was 15.2. The percentage of beets containing 13 per cent of sugar or over, having a coefficient of purity of the juice of 80 per cent or over, was 67. The percentage of beets containing 13 per cent and over of sugar and weighing 16 ounces or more, net, was 42.

The analyses made at the agricultural experiment station of Kansas have been consolidated and tabulated by counties. The table of analyses follows:

Summary of analyses of beets from Kansas.

[Compiled from report of experiment station.]

County.	Number beets in samples.	Number samples.	Average weight.	Cane sugar in juice.	Coefficient of purity.	County.	Number beets in samples.	Number samples.	Average weight.	Cane sugar in juice.	Coefficient of purity.
			Ozs.	*Per ct.*					*Ozs.*	*Per ct.*	
Allen	10	1	14	10.64	72.0	Lyon	14	2	16	13.29	79.5
Atchison	17	2	17	12.61	79.5	Marion	53	6	16	11.23	71.8
Barber	14	2	12	14.91	72.5	Marshall	49	5	25	12.20	79.4
Barton	4	1	34	10.35	74.0	McPherson	7	1	7	13.08	76.0
Bourbon	8	1	5	13.88	75.0	Montgomery	21	3	15	11.39	74.6
Brown	10	1	21	11.29	81.0	Morris	14	2	15	14.01	74.5
Butler	22	4	18	10.86	70.8	Nemaha	48	4	23	10.30	74.2
Chase	6	1	14	11.61	77.0	Osage	20	4	16	12.17	77.2
Cheyenne	10	1	17	12.14	79.9	Osborne	10	1	16	12.39	70.0
Clay	37	3	28	11.21	78.0	Ottawa	27	4	22	12.90	78.2
Cloud	93	9	20	11.65	79.2	Pawnee	8	1	4	8.52	70.0
Coffey	4	1	20	15.13	78.0	Phillips	21	2	19	12.16	79.5
Crawford	12	1	14	13.87	82.0	Pottawatomie	30	3	16	12.20	83.6
Do	3	1	28	21		Pratt	14	2	8	12.19	75.0
Dickinson	20	4	17	12.29	77.0	Rawlins	8	1	16	9.57	73.0
Doniphan	15	1	24	13.67	84.0	Reno	18	2	12	13.78	79.5
Douglas	11	2	20	12.48	77.5	Republic	49	4	18	10.69	74.5
Edwards	6	1	12	11.12	71.0	Rice	6	2	14	11.71	74.5
Elk	14	2	21	14.04	83.0	Riley		3	21	8.98	70.3
Ellsworth	5	1	17			Rooks	21	2	16	13.39	80.5
Finney	6	1	19	14.14	74.0	Rush	10	1	20	11.88	77.0
Franklin	6	1	16	11.86	77.0	Russell	12	3	10	11.49	71.0
Geary	6	1	13	9.51	70.0	Saline	16	2	9	15.78	84.0
Graham	31	3	18	12.83	76.0	Sedgwick	12	2	12	11.23	74.0
Grant	6	1	16	15.47	78.0	Shawnee	29	3	15	12.19	77.3
Harvey	6	1	5			Sheridan	20	2	21	11.59	78.5
Do	6	1	14	12.83	78.0	Smith	10	1	28	11.12	78.0
Jackson	14	1	20	11.17	73.0	Sumner	7	1	18	13.38	76.0
Jefferson	6	1	15	11.82	76.0	Waubaunsee	23	2	15	12.14	77.5
Jewell	40	4	19	11.12	77.3	Wallace	6	1	19	11.58	76.0
Johnson	14	2	18	14.23	83.0	Washington	99	10	27	10.79	75.2
Labette	3	1	20	8.76	67.0	Wichita	6	1	14	11.24	79.0
Lane	26	2	4	10.17	68.5	Wilson	36	5	14	13.12	81.0
Leavenworth	22	4	12	12.75	79.0	Woodson	10	1	7	14.32	73.0
Lincoln	16	3	28	11.38	79.6	Wyandotte	4	1	14	14.11	75.0
Logan	10	1	19	11.40	76.0						

The data obtained at the Kansas station corroborate in every respect those secured at the Department of Agriculture. It is evident that

fairly good beets can be grown in Kansas, and there are doubtless seasons when exceptionally rich beets might be secured. In general, however, it may be said that there is no immediate prospect of the successful establishment of the sugar-beet industry in that State, unless it might be in some of the extreme western or northwestern counties, where irrigation might be practiced, and where the altitude is sufficiently high to secure a lowering of the temperature. One of the great causes of danger, however, is found in the hot southwest winds, which frequently blow over the State with disastrous consequences at the period when the crops are growing most rapidly. It will be seen that in many instances individual analyses obtained in Kansas are extremely satisfactory, as for instance, in Elk County, where two samples, including 14 different beets, showed an average weight of 21 ounces, an average content of sugar in the juice of 14 per cent, and an average purity of 83. Another sample is found in Saline County, where 16 beets, forming two samples, showed a sugar content of 15.8 per cent in the juice, with an average purity of 84. In this case, however, the beets were very much under size, the average weight being only 9 ounces. When, however, the data received from the counties are compared with similar data from the State of New York, the discrepancy observed is so great as to indicate, without further elucidation, the proper locality where the first development of the sugar-beet industry should be looked for.

In the light of our previous experiments, it must be evident that high-grade sorghum, developed from carefully selected seeds, has a better prospect in Kansas of being a profitable sugar-producing plant than the sugar beet.

Kentucky.

Only a few samples, with the exception of those sent by the experiment station, have been received from Kentucky. This State being situated far south of the theoretical sugar-beet belt, it is not to be expected that the results of the analyses would be particularly encouraging. The mean weight of the six samples received was 16 ounces, the mean percentage of sugar 11.9, and the purity 71.5. The six samples included four from the experiment station. The beets received were small, and the percentage of sugar only a trifle under the minimum which is advisable for profitable sugar making. The purity, however, is excessively low, and this seems to be characteristic of beets grown too far south, the purity coefficient usually falling in a more rapid proportion than the content of sugar.

Large numbers of samples were received from the experiment station in addition to those analyzed above, which were grown upon the special plot, which will be mentioned later on, and under the most favorable conditions of culture. The beets which were sent to the Department were of good size and mostly of a favorable shape, but the analytical data were very disappointing, falling a great deal lower than

was expected. Nine samples of White Improved Imperial Elite, planted May 8 and harvested December 9, had an average weight of 33 ounces, with 4.9 per cent of sugar. Three samples of original Kleinwanzlebener had an average weight of 23 ounces, with 10.8 per cent of sugar. Sixteen samples of Vilmorin's Improved had an average weight of 25 ounces, with 6.4 per cent of sugar. Thirty-nine samples of the Demesmay variety had an average weight of 29 ounces, with 5.3 per cent of sugar. All of these beets were somewhat overgrown, but not sufficiently so to account for the extremely low percentage of sugar. A large additional number of samples had been selected for analysis, but the results of the preceding analyses were so discouraging as to render the further prosecution of the analytical work unnecessary. This subject will be mentioned again when the experiments in the specially cultivated plots with high grade seeds are discussed.

Maryland.

All the analyses of the samples of beets grown in Maryland were made in the laboratory of this division, the agricultural station at College Park not having undertaken any work of this kind. The whole number of samples received from the State was 29. The mean size of the beets was 19 ounces, the mean percentage of sugar in the beets 11.4, and the mean purity of the juices 79.1. In respect of size, the samples from Maryland are about the mean. The purity of the juice is almost up to the minimum standard, but the percentage of sugar in the beet is about 0.6 less than is advisable for manufacture.

In regard to climatic conditions, as has been before intimated, the State of Maryland occupies a somewhat peculiar position. There is a considerable area along the eastern shore, next to the ocean, where the average summer temperature is 71°. In the western part of the State, after a long deflection to the north, the isotherm of 70° may again be found. Lying immediately south of the isotherm of 71°, in the northern portion of Maryland, are found some very fine valley lands where the conditions of culture may be considered favorable. These lands are underlaid by limestone, which in many cases comes to the surface. Theoretically they are a little too warm for the most successful culture, but lying so near the favorable thermal belt there may be reasonable hopes of successful culture in many localities. In the western portion of the State, where the thermal conditions are favorable, we find the mountain ranges, and the low temperature of the summer is due to the high elevation. The quantity of table lands upon the tops of the mountains, however, is not sufficiently great to warrant the expectation of the founding of a great industry. There is no doubt, however, of the possibility of growing very rich beets on these table lands. In general it may be said that the State of Maryland is not very favorably situated for the culture of sugar beets, but there are circumscribed localities

within the State where it is desirable to conduct further experiments. It is therefore earnestly hoped that the agricultural experiment station of the State will make a more careful agricultural survey of the possibilities of the culture of sugar beets therein.

Michigan.

The southern peninsula of Michigan is favorably situated for the culture of sugar beets, both in respect of thermal conditions and rainfall. The soil is also for the most part well suited to sugar-beet culture. In going northward, however, it becomes more sandy until finally the pine regions are reached, where a soil without fertilization would not be sufficiently rich to produce large crops. The well-known tendency of a sandy soil, with proper meteorological conditions, to produce beets of a high purity is well illustrated in the samples which have been received from Michigan. In all, 450 samples from the State were sent to this laboratory for analysis, 400 of them being from Saginaw County and grown under the supervision of Messrs. Higgins & Lenders.

In regard to the results from particular counties, attention should be called to the fact that the samples from Allegan were all enormously overgrown, the average weight of the beets being 62 ounces and the corresponding content of sugar and the coefficient of purity low. The results from Calhoun County, in the southern part of the State, are particularly favorable, the average weight of the samples being 17 ounces, average content of sugar in the beet 15.8, and the average purity 83.2. The greater part of the samples having come from Saginaw County, the average data for this county are almost the same as those of the State, with the exception that the purity is considerably higher. The average composition of the 400 samples from Saginaw County was as follows: Average weight, 22 ounces; sugar content in the beet, 14.8 per cent, and purity, 83.3. For the whole State—450 samples—the average weight was 22 ounces, average sugar content 14.7 per cent, and average purity 81.1.

The agricultural experiment station of Michigan, in cooperation with the Department of Agriculture, also made an extensive series of investigations, a résumé of which is given below:

Results by counties of the cultivation of sugar beets in Michigan in 1897.

The following table is given containing the number of samples sent to the station from each county, the average per cent of sugar in the juice, and coefficient of purity of all samples sent. Seed was distributed in sixty-eight counties, and from the table below it will be seen that samples have been received from sixty-four of them. The average per cent of sugar in the juice of beets of the whole State, when grown on the proper kind of soil and from the right kind of seed, is 16.40, and the coefficient of purity is 84. An average of 16.40 per cent of sugar for the whole State, far exceeding the best districts in France and Germany, is both surprising and gratifying.[1]

[1] These data are obtained by omitting from the table the analyses of samples which were known to have been grown under unfavorable conditions.—H. W. W.

Analyses of sugar beets grown in Michigan and analyzed by the Michigan agricultural experiment station.

County.	Total number of samples.	Sugar in juice.	Coefficient of purity.	Samples rejected for bad soil or seed.	Number of samples on right soil and proper seed.	Sugar in juice in such samples.	Coefficient of purity.
		Per cent.				*Per cent.*	
Alger	1	14.22	80	0	1	14.22	80
Allegan	3	15.67	86	0	3	15.67	86
Alpena	2	15.01	80	0	2	15.01	80
Antrim	2	15.97	82	0	2	15.97	82
Arenac	8	16.77	85	0	8	16.77	85
Baraga	1	14.10	76	0	1	14.10	76
Barry	4	14.90	81	0	4	14.90	81
Bay	10	15.53	84	1	9	16.00	84
Berrien	3	17.83	87	0	3	17.83	87
Branch	3	16.62	84	0	3	16.62	84
Calhoun	6	15.82	84	0	6	15.82	84
Cass	2	15.44	82	0	2	15.44	82
Charlevoix	7	17.58	87	0	7	17.58	87
Clare	2	16.80	84	0	2	16.80	84
Clinton	4	15.89	84	1	3	16.05	86
Crawford	1	15.25	81	0	1	15.25	81
Eaton	5	17.50	83	0	5	17.50	83
Emmet	1	15.02	82	0	1	15.02	82
Genesee	6	14.75	82	1	5	16.14	84
Grand Traverse	7	15.75	82	2	5	15.91	83
Gratiot	6	16.09	83	0	6	16.09	83
Hillsdale	2	16.71	84	0	2	16.71	84
Huron	6	17.47	85	0	6	17.47	85
Ingham	36	16.43	87	1	35	16.53	87
Ionia	4	16.36	82	0	4	16.36	82
Iosco	6	13.18	77	1	5	14.22	79
Iron	1	18.18	80	0	1	18.18	80
Isabella	4	14.09	78	1	3	16.41	82
Jackson	7	19.74	74	5	2	18.16	86
Kalamazoo	17	15.45	82	3	14	15.87	82
Kalkaska	2	16.91	83	0	2	16.91	83
Kent	16	15.55	83	2	14	15.85	84
Lapeer	2	17.71	84	0	2	17.71	84
Leelanaw	3	18.77	89	0	3	18.77	89
Lenawee	5	15.96	85	0	5	15.96	85
Livingston	2	14.34	80	0	2	14.34	80
Mackinac	1	16.22	85	0	1	16.22	85
Macomb	11	16.11	82	2	9	16.91	83
Manistee	6	17.09	84	0	6	17.09	84
Mason	5	16.54	85	0	5	16.54	85
Mecosta	4	16.67	84	0	4	16.67	84
Menominee	6	16.58	84	0	6	16.58	84
Midland	2	17.62	86	0	2	17.62	86
Missaukee	1	15.79	84	0	1	15.79	84
Monroe	2	16.41	84	0	2	16.41	84
Montcalm	2	17.64	83	0	2	17.64	83
Muskegon	9	16.03	85	0	9	16.03	85
Newaygo	13	16.11	81	1	12	16.54	81
Oakland	7	15.29	83	1	6	16.26	83
Oceana	11	16.54	86	0	11	16.54	86
Ontonagon	4	15.15	79	0	4	15.15	79
Osceola	2	16.55	85	0	2	16.55	85
Otsego	1	18.00	90	0	1	18.00	90
Ottawa	14	16.47	83	0	14	16.47	83
Saginaw	127	15.99	84	4	123	16.13	84
St. Clair	31	17.53	83	1	30	17.64	83
St. Joseph	1	12.16	76	0	1	12.16	76
Sanilac	11	18.15	86	0	11	18.15	86
Shiawassee	4	16.89	83	0	4	16.89	83
Tuscola	1	18.94	89	0	1	18.94	89
Van Buren	4	13.82	80	0	4	13.82	80
Washtenaw	4	16.10	84	0	44	16.10	84
Wayne	9	16.12	84	1	8	17.08	85
Wexford	9	14.59	79	1	8	15.25	81
Total	493				465		
Average		16.08	83			16.40	84

Five samples from Oceana County are not included in results of analyses, because they were dried and damaged by keeping.

Interesting data in regard to cost of culture were obtained at the Michigan station. The plats were planted on the 8th of May, and harvested on the 6th of October. After throwing the dirt away from the beets by a plow they were pulled by hand and the leaves and stems removed. Owing to the deep subsoiling and thorough preparation of the ground, the beets were found wholly embedded in the soil, none of them having been pushed above the surface. The average weight of the beets before the removal of the necks was about 2½ pounds. The following table gives the total labor, calculated to 1 acre, required for growing and harvesting the beets:

	Man and team.	Man.
	Hours.	*Hours.*
Plowing and subsoiling	12.00	.....
Harrowing	3.75	.....
Marking	.80	.....
Planting	.....	3.25
Cultivating	15.00	.....
Thinning and hoeing	.....	75.90
Harvesting	4.60	130.75
Total	36.15	209.90

The hand labor in harvesting was performed by boys at 8 cents an hour. The work of hoeing and thinning was performed by men at 12½ cents an hour. The cost of team work is computed at 25 cents an hour for man and team. On the above basis, the total cost of planting, cultivating, and harvesting an acre of beets at the Michigan Experiment Station was $29.40. The yield per acre, the percentage of sugar in the juice, and the purity for each variety grown are shown in the following table:

Variety.	Yield per acre.	Sugar.	Purity.
	Pounds.	*Per cent.*	
Wohanka	23,615	15.22	86
Improved Kleinwanzlebener	25,678	16.40	91
Original Kleinwanzlebener	27,368	18.27	94
Government Kleinwanzlebener	25,648	17.78	94
La Plus Riche	29,205	18.78	92
Government Kleinwanzlebener	32,327	17.78	94
Hoerning's Improved	24,500	15.20	89
Floto's Improved	20,200	13.21	88
Kleinwanzlebener on muck	.....	12.96	75

Full details of all the experiments conducted in Michigan by the agricultural experiment station are found in Bulletin No. 150 of that station, issued in December, 1897, by Director C. D. Smith and Chemist R. C. Kedzie.

The study of the two sets of data secured at the Department of Agriculture and by the agricultural experiment station of Michigan is sufficient to demonstrate the fact that the southern peninsula of Michigan has great possibilities for the development of the sugar-beet industry. When it is remembered that the most of those who grew the samples had had no previous experience in the matter, that no systematic fertilization was attempted, and that in many instances the soil was

improperly prepared, the remarkably favorable results obtained are the more convincing. It is evident that all the southern portion of the Southern Michigan Peninsula, in conjunction with the northern part of Indiana, forms an area in which the future will see a remarkable development of the sugar-beet industry.

Minnesota.

Forty-nine samples from the State of Minnesota were received for analysis at the laboratory of the Department of Agriculture. The mean weight of the samples received was 24 ounces, the mean percentage of sugar in the beet 11, and the mean purity coefficient 79.2.

Great variations are shown in the samples received from different parts of the State. One of the best series of results was obtained from Freeborn County, in the southern part of the State, from which twelve samples were received, having an average weight of 20 ounces, an average content of sugar in the beet of 14.1 per cent, and an average coefficient of purity of 82.3.

Another good series of samples, though less in number, was from Ottertail County, in the western part of the State, from which four samples were received, having an average weight of 23 ounces, a mean content of sugar in the beets of 14.9 per cent, and a mean coefficient of purity of 82.1. The general average from the State was lowered by a large number of very poor samples, which evidently had been grown under extremely unfavorable conditions.

The period of growth in Minnesota, while a little short, is nevertheless favorable from other considerations, especially in the southern and eastern portions of the State. Toward the northwestern portion of the State the rainfall is somewhat uncertain, and the autumn is perhaps a little too cold. As has been intimated before, the chief difficulty in Minnesota in the establishment of the beet-sugar industry is not in securing a proper growing season, but in having a sufficient time to properly harvest and protect the beets. The sudden, and often early, advent of winter in the northern and western portions of the State will be the cause of difficulties of a serious nature in the harvesting and siloing of the beets. These are factors which intending investors will do well to carefully consider. In general, the conditions of growth are so favorable as to warrant the careful study of the soils of the State by the agricultural experiment station with a view to selecting those localities where the conditions of culture are most favorable. In a State of such vast area it is far better to determine those restricted sections where the conditions are most favorable rather than try to establish the industry indiscriminately in every portion of the State.

In cooperation with the Department of Agriculture, the agricultural experiment station of Minnesota conducted an extensive series of culture experiments in various parts of the State. The general results of the experiments are indicated in the report of the chemist of the station, which follows.

EXPERIMENTS CONDUCTED BY THE AGRICULTURAL EXPERIMENT STATION OF MINNESOTA.

The seed from which the beets were grown was obtained from a variety of sources. Some procured seed from the stock which the legislature directed the State treasurer to purchase. About 100 pounds of seed were obtained from the United States Department of Agriculture and distributed by the experiment station. Some seed was obtained direct from Germany, while a few obtained seed from seed dealers and other sources. As a rule, the seed was of good quality. Only a few instances of poor seed were reported. There was but little difference as to the quality of the beets produced by the seed furnished by the State and by the Department of Agriculture. At the experiment station the average of four plots of Kleinwanzlebener beets grown from State seed showed 17.5 per cent sugar, with a purity coefficient of 86.7, while the average of four plots of Kleinwanzlebener beets grown from United States Department of Agriculture seed gave 17.4 per cent sugar and a purity coefficient of 87.8.

The past season has not been one particularly favorable to the production of the highest quality of beets. It has been the most unfavorable season in nine years. As a whole, however, the results have been satisfactory, and I consider them of unusual value, because they indicate the quality of the beets which are produced in an unfavorable rather than a favorable season.

At the experiment station the average of those plots which were grown under normal conditions gave a sugar content of 17.4 per cent and a purity coefficient of 87.3.

There is one factor in our favor which I think has been overlooked in considering desirable locations for sugar-beet factories, and that is, we have never lost a sugar-beet crop from hot, dry winds, which occasionally occur in some of the prairie States.

About three hundred samples of beets have been tested during the season. In many cases the results were lower than they would have been if the beets had been properly cultivated. In one of the tables the results are given of some of the beets which have been grown under abnormal conditions. In one case twenty-five minutes' time was spent on a quarter acre of beets, while in another case the seeds were planted five inches. These results, while they possess no value as indicating the quality of sugar beets which may be produced in a locality, are nevertheless valuable, because they emphasize the importance of the right kind of cultivation for sugar-beet production.

Sugar beets grown at the Minnesota Experiment Station.

	No. plot.	No. tests.	Sugar.	Purity coefficient.	Average weight.
Highest results: Rows 18 inches apart and beets 4 inches in row	.....	.....	*Per cent.* 18.5	*Per cent.* 92.5	*Ounces.* 12.8
Lowest results: Rows 30 inches apart and beets 10 inches in row	.....	.....	14.2	78.0	18.4
Average of rows:					
24 and 30 inches apart and beets 4 to 6 inches in row.	8	16	16.0	86.1	15.1
24 and 30 inches apart and beets 6 to 10 inches in row	8	16	15.8	85.5	14.9
14 and 18 inches apart and beets 8 and 10 inches in row	8	16	15.9	85.4	14.1
14 and 18 inches apart and beets 4 and 6 inches in row	8	16	17.4	87.3	11.6

The cultivation of the beets was under the supervision of the Agricultural Division. The analyses were all made by the chemist of the station.

The analytical data obtained are summarized from the details of the chemist's report in the following table:

Total number of analyses reported	143
Average weight of the beets (ounces)	17
Average per cent of sugar in the juice	13.8
Average coefficient of purity	81.8

The classification of results is made in several portions, namely, analyses of miscellaneous samples from the State at large and analyses of special samples from definite localities. In the analyses of miscellaneous beets collected from different parts of the State, with the exception of those specially mentioned below, thirty four samples were examined. The mean weight of the beet is not given in this table of analyses. The mean percentage of sugar in the juice is 14.25 and the mean purity coefficient 82.

Sixteen samples grown at Mankato, Minn., showed an average weight of 21.9 ounces, a mean percentage of sugar in the juice of 12.8, and a purity coefficient of 80.2.

Ten samples grown at Winton and Stockton had an average weight of 17.1 ounces, contained 13.7 per cent of sugar in the juice, and had a purity coefficient of 81.9.

Eighty-three samples grown at Albert Lea had an average weight of 16.6 ounces, contained 13.8 per cent of sugar in the juice, and had a purity coefficient of 82.1.

In general, it will be observed that the results obtained on the samples sent directly to the station were better than those secured at the laboratory in Washington. Upon the whole, the results of the work done at the experiment station are eminently satisfactory, especially as they were accompanied with the statement of the director that the conditions were the most unfavorable, for the development of a crop of sugar beets, which had been known in the State since the commencement of the experiments in this direction, in 1888.

The results of the analyses of the beets grown at the station are extremely satisfactory. The average weight of the beet, to be sure, is somewhat low, but this doubtless was due to an unfavorable growing season. The mean percentage of sugar in the beets grown in different plots is exceptionally fine, and the coefficient of purity in one instance is higher than could reasonably be expected with the best kind of culture. Only in one of the plots cultivated on the station are the results unsatisfactory, and in this case it is the coefficient of purity especially which has fallen below the standard.

Missouri.

Very extensive experiments were made in Missouri, about 4,000 samples of seed having been distributed, and over 600 returns made. There were sent directly to the Department of Agriculture 324 samples, detailed analyses of which are found in the preceding tables. The average weight of the samples received was 20 ounces. The mean percentage of sugar in the beet was 11.7 and the mean purity 73.5. Many individual samples from the State show excellent qualities, but reliable judgment, as intimated before, can only be based upon large numbers of analyses. Among the counties furnishing beets of high quality may be mentioned Barton, in the southwestern part of the State. Three samples were received from this county, all of them of

rather large size and fine content of sugar, the mean size being 27 ounces, the mean content of sugar in the beet 15.3 per cent; only the purity in all cases was a little low, the mean being 77.3. Benton County, in the center of the State, also showed good results, five samples having an average weight of 16 ounces, an average sugar content of 15.5 per cent, and an average purity of 77.1. The best single sample received was from Pulaski County, in the center of the State, the percentage of sugar being 18.3, the purity 86.1; but the weight was low, namely, only 12 ounces.

Two hundred and ninety-nine samples of beets were sent directly to the agricultural experiment station of Missouri and analyzed in the laboratory of that station. The mean results, by counties, obtained on analysis are given in the following table:

Summary of analyses of beets grown in Missouri.

[From Report of Missouri Experiment Station.]

County.	Number of samples.	Average weight.	Sucrose in juice.	Coefficient of purity.	County.	Number of samples.	Average weight.	Sucrose in juice.	Coefficient of purity.
		Ozs.	*Per ct.*				*Ozs.*	*Per ct.*	
Adair	2	29	14.31	82.89	Livingston	1	12	9.75	70.34
Andrew	1	22	12.16	76.76	McDonald	5	19	13.83	80.05
Audrain	1	32	7.10	56.66	Macon	1	14	14.11	70.89
Barry	4	24	12.85	73.96	Madison	2	20	13.07	71.85
Barton	1	41	16.97	81.62	Maries	1	28	12.95	78.92
Bates	1	22	11.56	76.82	Marion	4	32	9.76	69.32
Benton	2	16	18.19	86.36	Mercer	1	44	13.51	80.22
Boone	2	29	8.19	63.78	Mississippi	3	24	10.57	75.00
Buchanan	4	34	12.20	81.88	Monroe	2	11	7.71	57.57
Butler	1	8	6.47	58.23	Montgomery	5	21	12.62	78.11
Caldwell	6	35	12.99	80.16	New Madrid	2	20	12.30	79.03
Callaway	3	33	12.45	76.45	Nodaway	4	42	11.66	72.61
Carroll	2	28	11.08	75.03	Oregon	1	20	8.37	67.12
Cass	3	22	16.36	84.75	Ozark	1	6	13.81	77.15
Cedar	1	7	11.08	78.86	Perry	1	16	14.06	74.86
Chariton	4	16	12.35	74.24	Pettis	8	24	10.05	65.67
Christian	3	32	11.14	67.86	Phelps	4	13	11.31	75.56
Clark	1	54	12.80	77.76	Platte	4	27	12.11	74.74
Clay	1	36	8.87	67.16	Pike (average)	63	21	10.14	75.55
Cooper	4	19	8.43	61.69	First harvest	38	21	10.94	76.81
Crawford	3	20	11.95	81.27	Second harvest	25	21	9.34	74.30
Dade	2	30	10.56	67.95	Randolph	2	16	14.30	80.17
Dallas	2	16	14.06	74.95	Ray	6	44	10.95	72.40
Dekalb	2	46	10.11	70.40	Saline	3	21	13.74	76.39
Dent	1	10	14.51	72.66	Schuyler	3	25	15.74	82.30
Douglas	2	4	15.19	88.68	Scotland	2	20	15.51	79.46
Franklin	3	30	9.31	70.81	Scott	3	26	9.70	66.43
Gasconade	2	19	10.88	68.60	Shannon	3	12	11.94	76.10
Gentry	7	31	12.68	75.42	Shelby	1	8	7.87	76.26
Greene	1	20	12.27	77.17	St. Charles	5	58	11.21	78.36
Grundy	1	18	12.16	71.11	St. Clair	1	6	21.02	92.19
Harrison	1	6	18.45	.....	St. François	2	22	9.68	61.99
Henry	3	25	11.05	66.76	St. Louis	6	27	13.53	82.80
Hickory	1	24	11.88	76.66	Stoddard	1	16	14.79	74.19
Holt	4	29	10.26	73.29	Sullivan	2	26	16.08	85.92
Howell	2	28	13.10	78.18	Taney	3	15	13.08	74.95
Iron	2	13	13.11	79.76	Texas	2	13	14.33	78.47
Jackson	4	36	12.14	79.23	Vernon	7	36	13.17	80.30
Jasper	6	27	11.04	72.57	Warren	2	36	8.07	60.48
Jefferson	3	17	10.71	66.73	Washington	1	28	10.71	73.71
Johnson	5	22	11.90	72.54	Wayne	1	22	13.08	.....
Knox	1	46	12.81	74.87	Webster	1	14	13.12	80.58
Laclede	5	19	12.36	68.62	Worth	1	34	11.35	73.13
Lafayette	4	25	11.45	74.08	Wright	4	13	14.01	83.24
Lawrence	1	24	12.12	78.06					
Lewis	2	25	15.60	82.27	Total and mean	301	28	11.1	74.9
Lincoln	1	42	7.94	57.18					
Linn	5	28	12.28	72.21					

Of the whole number of samples, the percentage of those containing 13 per cent or more of sugar in the beet was 24; the percentage of these beets with a sugar content of 13 per cent or over having a purity coefficient of 80 or over was 83; the percentage of the number of beets containing 13 per cent of sugar which had a purity coefficient of 80 or over and weighing 16 ounces or over was 68.

The average percentage of sugar in the beet for the whole number of samples examined at the station was 11.1. The average coefficient of purity 74.9, and the average weight in ounces 25. A tabular comparison of the mean results obtained by the Missouri station and in the laboratory of the Department will be interesting:

	Total number of samples.	Average weight.	Sugar in juice.	Purity coefficient.
		Ounces.	*Per cent.*	
United States Department of Agriculture	324	20	11.7	73.5
Agricultural experiment station of Missouri	301	28	11.1	74.9

As will be seen above, there is a remarkable agreement between the mean results obtained in the two laboratories. The average size of the samples received at Washington was smaller than that of the beets analyzed at the agricultural experiment station of Missouri, and this is doubtless the cause of the slightly increased mean percentage of sugar obtained in the laboratory of the Department of Agriculture. A general study of the results obtained leads to the inevitable conclusion that Missouri is not very favorably situated for producing beets of the highest quality. It is possible to secure, in some instances, results which are exceptionally favorable, but that such results could be secured continuously, and from season to season, is not probable. The data show that the whole State of Missouri belongs in the same category, in respect of growing rich sugar beets, as the southern parts of the States of Ohio, Indiana, and Illinois. Even the northern counties of Missouri are too far south to give the best results. It is evident, however, in so far as yield is concerned, that Missouri is probably the equal of any State in the Union for growing beets of fine size and large tonnage per acre. Unless exceptional conditions favorable to manufacture are found in the State, it is not probable that the sugar-beet industry will gain a foothold for some time in competition with the more favorable localities farther north and east.

Montana.

Only four samples were received from the State of Montana at the laboratory of the Department of Agriculture. The average weight of the samples was 20 ounces, the mean percentage of sugar in the beet 14.4, and the mean purity coefficient of 77.8.

Analyses were also made by the agricultural experiment station of Montana. Fifteen analyses were made of samples grown on the

grounds of the station. The average weight of the samples was 14.8 ounces, the mean percentage of sugar in the beet 16.2, and the mean coefficient of purity of the juice 81.9. Thirty samples grown in the Gallatin Valley had a mean weight of 22 ounces, a mean content of sugar in the beet of 13.7 per cent, and a mean coefficient of purity of 76.4. Eight samples grown at Livingston had an average weight of 24.7 ounces, with a mean sugar content of 13.8 per cent in the beet, and a coefficient of purity of 74.3. Nine samples from Kalispell had a mean weight of 32 ounces, a mean content of 13. 5 per cent of sugar in the beet, and a mean coefficient of purity of 76.2. Four samples of beets from Missoula had an average weight of 32 ounces, a mean percentage of sugar in the beet of 12, and a mean coefficient of purity of 73.6. Four samples of miscellaneous origin had an average weight of 23 ounces, an average sugar content in the beet of 12.7 per cent, and a coefficient of purity of 74. The whole number of samples analyzed by the agricultural experiment station of Montana was 70, with a mean weight of 23 ounces, a mean content of sugar in the beet of 14.7 per cent, and a mean coefficient of purity of 77.

The results obtained at the experiment station show what can be done by careful culture, and indicate that Montana, under proper conditions, is capable of producing a fairly good sugar beet. The data in general are sufficiently encouraging to warrant the agricultural experiment station of the State in making a more thorough and careful agricultural survey of the possibilities of beet production.

Nebraska.

Thirteen samples grown in Nebraska were received at the Department of Agriculture for analysis. The mean weight of the samples received was 29 ounces, the mean percentage of sugar in the beet 12.9, and the mean purity coefficient 76.9. The studies which have been made in Nebraska have been so thorough in previous years that it would not be advisable to make any deductions from so small a number of samples as was analyzed. In connection with the work done at the Department, the following report of the chemist of the agricultural experiment station of Nebraska may be considered:

RESULTS OF EXPERIMENTS IN NEBRASKA.

We distributed seed to 433 persons. Of these 158 responded, either by sending beets or written communication, or both. Of the 158, 106 returned samples of beets for analysis; 52 reported failure to secure crop. Of the 52 reporting failures, 14 said that the seed failed to germinate; 14 ascribed failure to dry weather; 24 gave various reasons for failure, 13 stating that the crop was destroyed by grasshoppers; 4 lost their crop by reason of stock incursions, and 7 through general neglect.

Putting these figures in the form of percentages: 36.4 per cent of those receiving seed responded in some way; 67 per cent of those who reported to us sent beets for analysis; 26.9 per cent of failures were attributed to dry weather; 26.9 per cent of failures were attributed to poor seed; 25 per cent of failures were caused by grasshoppers; 7.7 per cent of failures were caused by cattle; 13.4 per cent of failures were caused by general neglect.

The results of analyses showed an average of 12.34 per cent of sugar in the juice

with a purity coefficient of 75. The highest per cent of sugar in juice was 16.8 with a purity of 78.5. The lowest was 4.6 per cent with a purity coefficient of 45.

Beet seed was sent into sixty-seven counties and beets were received from thirty-six counties.

The average results obtained agree very closely with those secured in the laboratory of the Department of Agriculture.

So long a time has elapsed since sugar-beet growing was commenced in Nebraska on a large scale that it is possible to form some idea of the adaptability of that State for beet growing. The soils of Nebraska are mostly very fertile, with a fairly level surface, and are well suited in this respect to beet culture. The climatic conditions, as will be seen by consulting the map, are somewhat variable, and the rainfall in parts of the State is scant and in all parts of it very uncertain in respect of distribution. Periods of extremely wet weather are apt to alternate with long droughts. Hot winds may be expected over many parts of the State during the period of most rapid growth, and these winds are extremely injurious to all kinds of vegetation. The winters are apt to come on early and with severity, rendering the harvesting season somewhat precarious. There is no doubt of the fact that good beets can be grown under favorable conditions in Nebraska, but the uncertainties of the season are such as to indicate that there will not be a very rapid expansion of the industry in that State until more favorable areas have been thoroughly exploited. For details in regard to Nebraska the reports of the agricultural experiment station of Nebraska, at Lincoln, may be consulted. For about eight years this station has been engaged in the study of this question, and has published numerous and valuable bulletins, many of which can still be obtained by applying to the director of the station.

Nevada.

A large portion of the State of Nevada, in fact the whole of the northern and western parts, lies within the thermal area suitable to beet culture. Twenty-one samples of beets were received at the Department of Agriculture from Nevada, the average weight of which was 25 ounces, the average content of sugar in the beet 16.6 per cent, and the average coefficient of purity 81.1. These samples all came from the parts of the State lying within the favorable thermal area. The agricultural experiment station of Nevada, at Reno, also made an investigation of the possibilities of growing beets in that State, and has submitted a report on the subject. In all, twenty-two samples were received at Reno for analysis, the average weight of which was 25 ounces, and the average content of sugar 16.9 per cent, the purity not being given. These data show a remarkable agreement with those obtained by the Department of Agriculture. The beets were grown entirely under irrigation. Some of them, however, received only one irrigation and others as high as five.

The results obtained at the station itself were in the highest degree satisfactory. The total number of samples grown and analyzed at the

station was ten, the mean weight of the beets was 19 ounces, and the mean percentage of sugar 18.9, purity coefficient not given.

Mr. Stubbs, the director of the station, in submitting his report, states that he distributed 90 pounds of the seed received from the Department to thirty farmers residing in fifteen counties. Only five of the thirty farmers sent samples for analysis. One reported failure from stock breaking into the field and destroying the crop; one, failure from lack of water, and one stated that the samples of seeds sent him did not arrive. Mr. John Harrison reports that there are 20,000 acres of land in a single body such as he used for growing his beets.

All the samples sent to the Department of Agricluture by Mr. Harrison, ten in number, were from Humboldt County; the average weight of the samples was 21 ounces, the mean content of sugar in the beets 18.8 per cent, and the mean coefficient of purity 83.1. It is evident that, if such beets as these can be grown in that locality, the 20,000 acres of land suitable to beet culture would suffice to maintain a large factory, which must of necessity prove eminently successful if fuel, limestone, and water can be had in sufficient abundance and sufficiently cheap to operate it. The cultural results in Nevada are of the highest significance. This State, which is devoted chiefly to mining, has very small agricultural interests, but if a few areas capable of irrigation, like that at Lovelocks, in Humboldt County, can be found, Nevada should become a beet producing State. The establishment of this agricultural industry could not fail to be of immense benefit to the Commonwealth. There is no other State in which the reports are more favorable, although it may be said that the number of samples is not sufficiently large to carry absolute conviction. Nevertheless, the uniform excellence of the samples can not be the result of accident, but must have been due to the favorable influences of soil and climate. The agricultural experiment station of this State will do well to make a more careful survey, and especially to map out the localities where the contour of the State is suitable to beet culture and where water can be obtained.

New Jersey.

As has been before stated, New Jersey is traversed from the south toward the north by the mean isotherm of 71° for the three summer months. A portion of it is therefore within the theoretical thermal belt for beet growing. In general, it may be said, however, that the temperature will be found a little too warm to secure the best results. On the other hand, the soil of New Jersey is of a sandy nature, suited to the growth of a beet with a high purity.

The data which have been collected during the season from New Jersey are encouraging. The whole number of samples received from the State was 31, the average weight 16 ounces, the mean content of sugar in the beet 14.2 per cent, and the coefficient of purity 81.4. Essex and Mercer counties each furnished seven samples; the results in Essex County were fairly good, but in Mercer County were poor. Ocean

County furnished eight samples, with a high average percentage of sugar and purity coefficient, but with a weight only half the normal.

No investigations were made by the experiment station of New Jersey, but Mr. James B. Vredenburgh, of Jersey City, conducted some very careful experiments at Freehold, in Monmouth County. The following report of Mr. Vredenburgh is interesting and contains valuable data.

RESULTS OF EXPERIMENTS IN NEW JERSEY.

May 20, 1897.—I had one-quarter acre clover sod plowed and prepared for planting.

May 22.—I had planted four kinds of beet seed, viz, a strip of 111 by 2 feet 9 inches or seven one-thousandths of an acre in imported Vilmorin.

A similar strip in imported Kleinwanzlebener; a similar strip in Government seed, and the balance of the quarter acre in cattle beets.

I fertilized the whole plot equally with 300 pounds of phosphate. I weeded the beets twice, cultivated them five times, and gathered them November 1.

I had one of each kind analyzed each week, commencing August 3, by an expert chemist, the result of which I herewith inclose:

Varieties.	Weight.	
	When gathered.	Without tops.
	Pounds.	*Pounds.*
The Vilmorin	258	239
The Government	279	258
The Kleinwanzlebener	236	220

The Vilmorin, therefore, produced at the rate of 17½ tons to the acre, without tops; the Government, 18 tons to the acre without tops; Kleinwanzlebener, 15 tons to the acre without tops.

It will be seen that by far the best result came from the Vilmorin, the purity of the juice in the analysis of November 1 being 88.20.

This latter result was from an average of three beets, one small, one middle size, and one large.

The cost of the labor, fertilizer, etc., on the one-quarter acre was about $15.

Results on farm at Freehold, Monmouth County.

Date.	Marked.	Weight of the beet.		Percentage of sugar.		Purity coefficient.
		With top on.	With top cut off.	In the beet.	In the juice.	
1897.		*Pounds.*	*Pounds.*			
Aug. 30	No mark	1.171	1.088	10.45	11.30	80.14
30	do	1.384	1.161	11.15	12.50	83.30
Sept. 8	do	1.481	1.168	11.75	12.55	79.40
8	do	1.251	1.000	11.85	.....	.....
15	Government	2.093	1.545	9.80	10.60	80.60
15	Kleinwanzlebener	1.704	1.329	11.40	12.00	83.90
15	Vilmorin	1.724	1.311	12.40	13.10	84.50
20	No mark (Jack)	0.587	0.505	14.30	15.60	83.40
27	Government	4.391	2.923	10.40	11.25	81.50
27	Kleinwanzlebener	4.491	3.000	10.10	10.35	77.24
27	Vilmorin	4.292	3.058	9.90	10.55	78.47
Oct. 4	Government	2.097	1.700	12.40	13.25	84.30
4	Kleinwanzlebener	1.633	1.225	12.00	13.10	82.40
4	Vilmorin	1.876	1.479	13.80	14.10	86.10
14	Government	1.662	1.474	11.50	12.75	80.20
14	Kleinwanzlebener	2.234	1.770	12.30	12.75	81.70
14	Vilmorin	1.706	1.474	14.20	15.65	84.10
20	Government	1.583	1.373	13.50	14.50	82.00
20	Kleinwanzlebener	2.415	2.037	11.90	12.70	81.90
20	Vilmorin	2.150	1.715	14.30	14.95	83.50
Nov. 1	Government	2.313	1.757	12.40	13.50	78.00
1	Kleinwanzlebener	1.380	1.000	13.10	13.80	83.10
1	Vilmorin	1.270	0.958	14.30	15.35	88.20

Excluding the analyses made before the 20th of September, which would be anterior to the manufacturing season, and including all of those made after that date, we find that the sixteen samples analyzed had an average weight of 27 ounces, a mean content of sugar of 12.5 per cent, and a mean purity of 82.3. These data, obtained by Mr. Vredenburgh, in conjunction with those secured from the analyses of the samples forwarded to Washington, indicate the possibilities of successfully establishing the industry in the State on the lands which are particularly suited thereto. As before stated, however, the danger from a slightly too high temperature must be expected, and while good beets, capable of yielding high percentages of sugar, and with high purities, may be grown in New Jersey, it is scarcely probable that they will reach as high a grade as those grown farther north.

New Mexico.

Only three samples grown in New Mexico were received at this laboratory for analysis. These were all grown in Mora County by the La Cueva Ranch Company. The average size of these samples was small, but the content of sugar and the coefficient of purity of the juice were high. In connection with this work the report of the director of the agricultural experiment station will be found of interest.

RESULTS OF EXPERIMENTS IN NEW MEXICO.

TABLE 1.—*Analyses in the chemical laboratory of the New Mexico Experiment Station prior to October 25, 1897.*

Locality.	Number of samples analyzed.	Average weight of beets.	Average per cent sugar in the juice.
		Pounds.	
New Mexico Agricultural Experiment Station, Mesilla Park:			
Harvested Sept. 15	31	1.21	11.02
Harvested Oct. 14	31	1.53	12.47
Blue Water:			
Harvested Sept. 8	4	1.38	10.50
Harvested Sept. 30	4	1.63	12.70
Albuquerque	3	1.73	13.16
Santa Fe	7	1.06	14.10
Cerro	3	1.04	17.03
Dorsey	1	1.60	12.60
Chapham	1	1.60	15.10
Tularosa	2	1.98	11.20
Anthony	1	1.18	11.50
Maxwell City	3	2.77	14.15
Hatch	1	2.35	11.50
Socorro	1	.48	15.50
Lordsburg	1	.55	16.20
Blossburg	1	3.55	10.80
Aztec Subexperiment Station	1	1.85	14.60
Averages, etc	96	1.61	13.18

TABLE 2.—*Analyses in the chemical laboratory of the New Mexico Experiment Station between October 25 and November 15, 1897.*

Locality.	County.	Number of samples analyzed.	Average weight.	Average per cent sugar in the juice.
			Pounds.	
Aztec Subexperiment Station	San Juan	5	1.5	16.8
Farmington	do	6	1.9	17.6
Jewett	do	1	1.9	13.5
Blue Water	Valencia	4	3.5	10.6
Perea	Bernalillo	2	2.7	12.5
Las Vegas	San Miguel	1	2.8	13.5
East Lasvegas	do	1	3.2	15.1
Pine Spring	Lincoln	1	1.5	13.5
Raton	Colfax	2	2.1	13.1
Maxwell City	do	1	1.7	15.3
Dorsey	do	1	1.1	15.4
Wagonmound	do	1	1.6	13.9
Hatch	Dona Ana	1	1.7	16.5
Santa Fe	Santa Fe	5	1.0	15.9
Hobart	do	1	1.9	14.9
Lacueva	Mora	6	1.1	17.6
Cerro	Taos	1	1.5	18.6
Averages, etc		40	1.7	15.3

TABLE 3.—*Analyses in the chemical laboratory of the New Mexico Experiment Station between November 15 and December 20, 1897.*

Locality.	County.	Number of samples analyzed.	Average weight.	Average per cent sugar in the juice.
New Mexico Agricultural Experiment Station, Mesilla Park.			*Pounds.*	
Harvested Nov. 16	Dona Ana	31	1.7	13.9
Harvested Dec. 15		27	1.6	13.9
Sample came in not marked		1	1.5	17.4
Watrous	Mora	1	.8	12.0
Lacueva	do	2	1.1	15.6
Los Lunas	Valencia	1	2.5	14.5
Blue Water	do	4	1.2	13.8
Roswell	Chavez	3	1.7	13.8
Hagerman	Eddy	3	1.2	13.5
Santa Fe	Santa Fe	3	.8	18.0
Espanola	do	5	1.6	14.1
Jewett	San Juan	1	2.2	13.0
Las Vegas Subexperiment Station	San Miguel	1	1.6	17.6
Averages, etc		83	1.6	14.1

Our work is still in an incomplete condition, as we have not had time to estimate the coefficient of purity and consider some other points in connection with these analyses. I beg to call your attention to the fact that nearly all of the beets analyzed here were grown by farmers who had had no previous experience in growing beets, and whose habits of farming are extremely loose. We can say definitely that if these beets had been grown under such conditions as would be expected to obtain upon a well-regulated farm, the results would have been very much more satisfactory. We know that the conditions under which the most of the samples grew on the station farm here were not of the most satisfactory kind, as we are trying experiments on time of planting, time of harvesting, variety testing, deep and shallow plowing, different modes of irrigation, etc. It is now established beyond a doubt that New Mexico can grow large crops of sugar beets, containing a very high percentage of sugar.

Located at Eddy, in the southeastern part of the Territory, there is already established a sugar-beet factory, doing a successful and profitable business.

In the northern portions of the Territory coal is comparatively cheap, and the

completion of a railroad now in process of building will very materially cheapen coal in the southern part of the Territory.

Limestone seems to be scattered pretty well throughout the Territory, and while we have not had time to go fully into this subject, the few analyses that we have made indicate that the Territory affords limestone of a very good grade. We have just taken a survey of the limestone and waters of the sugar-beet districts. The question of water is engaging our attention, too; and we believe that water of fairly good quality can be secured.

There is a lively interest taken in sugar-beet work in all parts of the Territory, and from the tables herewith inclosed the most favorable locations can easily be selected. Particular attention should be called to the Rio Grande Valley, especially the northern portion, and the Animas Valley. This latter has an extensive and abundant supply of very good water, but at present no railroad. This valley seems to be a very promising section for the production of sugar beets. See Aztec and Farmington in the tables.

The soils of the Territory contain, I think, about the average amount of nitrogen and phosphoric acid and about the usual amount of potash. They have a decided advantage over the soils in the rainfall districts, because the fertility is largely kept up by the plant food contained in the irrigating water, and nearly all that once gets on the soil remains, as very little, indeed, is lost by leaching and drainage.

We expect to publish a bulletin about the 1st of February, giving our results in detail.

The analyses which were made by the chemist of the agricultural experiment station of the samples received by him are classified in accordance with the time at which they were made. Ninety-six analyses made prior to October 25 showed an average weight of the samples of 26 ounces, with an average content of sugar in the beet of 12.5 per cent. The purity coefficient of the juice is not given.

Forty samples analyzed between the 25th of October and the 15th of November had an average weight of 27 ounces, with an average content of sugar in the beet of 14.5 per cent, the purity coefficient not being stated.

Eighty-three samples analyzed between November 15 and December 20 had an average weight of 26 ounces, and an average content of sugar in the beet of 13.4 per cent. The purity was not given.

It is evident that there are many localities in New Mexico where the conditions of temperature are most favorable to the growth of beets. There are also large areas of fairly level land which are capable of irrigation. Wherever the temperature of these regions is sufficiently low to permit the proper development of the beet, and where sufficient water for irrigation can be secured, there is reason to believe that the industry may be established and prove to be fairly profitable. While the summer days in New Mexico are not so long by an hour or more as in the regions farther north, the amount of sunshine which the growing beet will receive is practically as great as in more northern localities, because of the comparative absence of cloudy and rainy days. The remarks which have already been made in regard to the growth of beets on irrigated areas apply to New Mexico. This is a subject which demands the most careful scientific study, and the work which is now doing by the agricultural experiment station of the Territory is certain

to bear excellent fruits in the near future. New Mexico is provided with a beet-sugar factory in the extreme southwestern portion of the Territory, and thus a practical demonstration of the possibilities of beet growing can be made. It is difficult to secure definite data from this factory, but from the meager reports received it is believed that the season's work has not been so successful as had been expected from the results obtained during the preceding year. Accounts have been received of a mold or fungus attacking the beets, and it is also evident that the true principles of irrigation have not yet been thoroughly worked out. There should not, however, be anything discouraging in accidents of this kind, as the conditions, upon the whole, are such as to warrant the expectation of final success.

New York.

On January 16, 1894, in addressing the New York Farmers Club on the subject of beet sugar, I used the following words:

> The plateaus of the great West subject to irrigation are especially suited to the production of sugar beets. The same is true of the lands of certain portions of Nebraska and Dakota, of Iowa, Minnesota, and Wisconsin, of northern Illinois, Indiana, Ohio, and New York. Recently, in passing over the valley of the Genesee River, I was particularly struck with the quality of the soil and its suitability to beet culture. The valley of the Genesee is only a type of hundreds of thousands of acres in New York which could be profitably devoted to beet culture.

At that time practically no experiments had been made to determine the suitability of the soil and climate of New York for producing high-grade beets. In fact, not until the last year has any systematic attempt been made to ascertain the capabilities mentioned above. In the spring of 1896, in conversation with a committee of the board of trustees of the agricultural experiment station at Geneva, I urged upon them the desirability of studying the capabilities of New York for beet production. In 1897 the Department of Agriculture, in cooperation with the experiment stations at Geneva and Ithaca, conducted a series of investigations throughout the State of New York, which has given data of extraordinary interest and importance.

The climatic conditions, as respects temperature and rainfall, affecting the State of New York have already been discussed. It has been seen that there are two areas in which the thermal conditions are particularly favorable, separated by a large area where the mean summer temperature is less than 69°. It has already been pointed out, however, that a lower temperature than 69° is still highly favorable to the production of beets of superior excellence if coupled with conditions which permit their maturity and harvest in time to avoid the severe frosts of winter. These conditions exist in a marked degree throughout the whole of the region in New York lying between the Hudson River on the east and the Great Lakes on the west, excluding the extreme northern portion, where the altitude and mountainous character of the country preclude the possibilities of beet culture. The

whole of the area named, therefore, where the contour is favorable and the character of the soil suitable may be regarded as a prospective area of sugar-beet culture.

SAMPLES RECEIVED AT THE DEPARTMENT OF AGRICULTURE.

From the seed distributed to farmers in different parts of the State, 225 samples of beets were received at the Department of Agriculture for analysis. The mean weight of these samples was 21 ounces, the mean percentage of sugar in the beet 15, and the mean coefficient of purity 82.4. Every county in the State reporting results showed favorable data. The counties having the largest number of samples of course gave data which are the most instructive.

Cattaraugus County supplied 15 samples, with a mean weight of 18 ounces, a mean percentage of sugar in the beet of 15.1, and a mean coefficient of purity of 81.9.

Chautauqua County furnished 45 samples, with a mean weight of 21 ounces, a mean sugar content in the beet of 16.6 per cent, and a mean coefficient of purity of 82.7.

Erie County sent 37 samples, having a mean weight of 19 ounces, a mean content of sugar of 15.9 per cent in the beet, and a mean coefficient of purity of 83.9.

Oneida County was the source of 22 samples, with a mean weight of 14 ounces, a mean sugar content of 13.6 per cent, and a mean coefficient of purity of 81.8.

Ontario County furnished 22 samples, having a mean weight of 17 ounces, a mean content of sugar in the beets of 15 per cent, and a mean coefficient of purity of 83.4.

Yates County supplied 15 samples, having a mean weight of 23 ounces, a mean sugar content of 12.7, and a mean coefficient of purity of 79.6.

The uniformly good properties of so large a percentage of samples collected in the promiscuous way made necessary by the method of the experiments show beyond question the favorable auspices under which they must have been grown.

In addition to the special plot work on high-grade beets which was conducted under the supervision of the Geneva station, cooperative work by the Department of Agriculture, in conjunction with the farmers of the State, was also carried on. From the whole number of packages of seed distributed by the station, 135 samples of beets were received for analysis, and the results obtained, without distinction of locality, are shown in the following report of Director Jordan:

RESULTS OF EXPERIMENTS IN NEW YORK.

The number of samples reported is 135, which came from a sufficient number of points in the State to make them fairly representative of the conditions prevailing.

I make no report to you of the production, because in most instances, whenever the tonnage was reported, the figures appeared to us to be unreliable because of the methods used in reaching them.

Kleinwanzlebener.

Beets containing sugar.	Number of samples.	Average per cent sugar in beet.	Coefficient of purity.	Average weight of one beet.
Per cent.				*Ounces.*
11–12	4	12	76.5	20
12–13	11	13	75.4	18
13–14	10	13.8	80	14
14–15	11	14.7	80.3	17
15–16	15	15.8	84.3	14
16–17	11	16.5	85.3	16
17–18	13	17.6	85.2	14
18–19	3	18.5	85.9	13

Vilmorin Improved.

Number of samples.	Average per cent sugar in beet.	Coefficient of purity.	Average weight of one beet.
			Ounces.
3	11.7	75	16
5	12.8	76.7	24
9	13.8	82.4	19
8	14.8	83	16
17	15.6	82	16
9	16.6	87.5	15
6	17.8	85.4	18
2	18.6	83.8	24

My chief anxiety with regard to the development of the sugar-beet industry in New York is that farmers shall not reach unwarranted conclusions concerning the profits of their side of the work. I have no reason to believe that the industry will prove more profitable to our farmers than the production of several crops which we are now growing. I recognize, of course, the benefits of adding to our list of crops another one which will have a ready cash market.

There appears to be a move all over the State for the establishment of factories at desirable centers, and promoters are already in the field who are, as a rule, urging the farmer to invest in beet sugar-factory stock. I am very much afraid that there will be serious misdirection of capital, which will not only cause the farmer to lose money, but seriously disappoint him in regard to the benefits from growing sugar beets. My judgment is that the matter should be discussed by those who take the lead in the matter in the most conservative way, and both farmers and business men should be severely cautioned to proceed slowly and only after extended and careful investigation.

A carefully grown crop of sugar beets yielded on the experiment station farm this season at the rate of 16¼ tons per acre, carrying 15.2 per cent sugar in the beet and 16 per cent in the juice. No dependence should, in my judgment, be placed upon the reports of yields of 25 and 30 tons per acre of high-grade beets in this State.

In studying the report of Director Jordan we see that of the Kleinwanzlebener variety only four samples out of the whole number fell below the minimum of 12 per cent of sugar in the beets, and of the Vilmorin variety only three. This is without doubt a remarkable showing of excellence, in so far as the content of sugar is concerned. The caution of Director Jordan to proceed carefully in this matter, and with a due study of the factors, is perfectly in harmony with the tenor of the reports which have been issued by the Department of Agricul-

ture, on the subject of beet sugar, from time to time during the past fifteen years, and is deserving of careful consideration, both by intending investors and farmers. Our reports have constantly dwelt upon the danger of misdirected enthusiasm and failure to study properly all the factors entering into any enterprise connected with the manufacture of sugar.

The agricultural experiment station of Cornell University, at Ithaca, also cooperated with the Department in the experimental work in New York. Four hundred and twenty-five samples were received for analysis at the experiment station at Ithaca. The data obtained on analysis, arranged by counties, are given in the report of Director Roberts. In this report the percentage of sugar in the juice of the beet only is given, the mean being 16.9. Converting this number into terms of the sugar in the beet, the percentage becomes 16.1, which is one point higher than the mean percentage of sugar in the samples from New York analyzed by the Department of Agriculture. The coefficient of purity, 83.5, obtained at the Ithaca station is only a little over one point higher than that secured from the analyses by the Department of Agriculture.

Director Roberts, in his report, estimates that the mean yield per acre obtained in the State of New York was 17 tons, but as his estimate is made upon the returns made by the farmers, many of which are evidently too high, it is not final as a source of deductions in regard to the average yield which may be obtained. It is not at all likely that an average yield of 16 tons per acre could be obtained, even by the best culture.

The counties furnishing the data with the most weight are Broome, Chautauqua, Erie, Genesee, Monroe, Steuben, and Wayne. Chautauqua County, especially, is to be regarded on account of the mean data being based upon 122 separate samples, in which the mean percentage of sugar in the juice was 16.8, and the mean coefficient of purity, 83.5. The next highest number is furnished by Genesee County, where the mean percentage of sugar in the juice from 62 samples is 16.6, and the coefficient of purity, 82.9. Monroe, with 59 samples, showed a mean sugar content in the juice of 17.2 per cent, and a mean coefficient of purity of 83.9. Erie County, with 38 samples, gave a mean content of sugar in the juice of 17.9 per cent, and a mean coefficient of purity of 86.3. Wayne County furnished 27 samples, having a mean content of sugar in the juice of 16.7 per cent, and a mean coefficient of purity of 82.9. Broome County sent 25 samples, containing 16.2 per cent of sugar in the juice, with a coefficient of purity of 81.8; and Steuben County furnished 24 samples, containing 16.2 per cent of sugar in the juice, with a coefficient of purity of 82.6. Following is the report of Prof. Roberts:

The 500 pounds of sugar-beet seed sent us by the Department of Agriculture were distributed to over 300 farmers of the State, with directions as to preparation of the soil, planting, and cultivating. During the growing season, the larger part of

the plats was inspected by an officer of this station and observations made as to the general conditions found.

The season was a favorable one, and in nearly all cases the beets made good growth, and that the per cent of sugar was satisfactory will be shown by the table of analyses given later.

It is safe to say that the citizens of New York State, both capitalists and farmers, are thoroughly awakened to the importance of the subject of the manufacture of sugar from beets. During the season one factory has been in successful operation at Rome, N. Y. Other factories are contemplated, and at the present time agents are in France negotiating for machinery to be used in a large factory to be erected the coming season.

Officers of this station attended eight meetings of farmers and capitalists to give information and advice as to the advisability of locating factories in certain sections of the State. Abundance of capital is ready to be invested once the success of the industry is assured. Farmers feel that in the raising of sugar beets a new avenue is open for them, and in most parts of the State favorable for the growth of beets they are heartily favoring the new enterprise.

When the various experimental plats were harvested, agents from this station personally superintended the taking of the samples and the calculations of yield on 178 of the plats. To those farmers whose places we were unable to visit directions were sent as to how the samples should be taken and the yield estimated; so it is believed that this report of results is a fair statement of what can be done in New York State in the way of raising sugar beets.

The necessity now seems to be the education of the farmers in the system of intensive culture necessary for the successful raising of the beets. The farmers appreciate the importance of this instruction, and are eager to learn. It is safe to predict that the manufacture of sugar from beets is to be one of New York's prominent industries in the near future.

The following report is furnished by our chemists, summarizing the results by counties:

Report of sugar-beet experiments in New York, 1897.

County.	Sugar in juice.	Purity coefficient of juice.	Total number of samples analyzed.	County.	Sugar in juice.	Purity coefficient of juice.	Total number of samples analyzed.
	Per cent.				*Per cent.*		
Albany	17.25	86.6	1	Oneida	16.16	82.1	4
Broome	16.23	81.8	25	Onondaga	17.40	86.6	1
Cattaraugus	16.94	84.5	15	Orleans	17.20	86.1	3
Cayuga	17.34	84.3	10	Oswego	14.45	76.1	1
Chautauqua	16.83	83.5	122	Saratoga	20.25	86.6	1
Erie	17.93	86.3	38	Schuyler	16.26	79.7	2
Genesee	16.62	82.9	62	Seneca	16.58	83.2	5
Herkimer	13.85	79.2	1	Steuben	16.24	82.6	24
Jefferson	16.16	81.0	3	Tioga	18.73	82.7	2
Livingston	19.25	85.6	1	Tompkins	17.49	83.1	8
Monroe	17.22	83.9	59	Wayne	16.74	82.9	27
Montgomery	15.08	79.3	3				
Niagara	17.31	83.4	7	Average	16.89	83.5	425

From the foregoing data, the conclusion is inevitable that the State of New York stands among the first in the Union in its capabilities of producing beets with a high content of sugar and a high purity. The meager data at hand also show that a fair tonnage per acre can be secured. It is evident that with proper fertilization and rotation of crops the fertility of the soil can not only be maintained, but even increased, so that it is not unreasonable to expect, under the best con-

ditions of culture, that the mean tonnage per acre produced in the State of New York will be quite equal to that of the best sugar regions of Germany. Judging by the data obtained from a single season alone, there is no sugar-beet producing country of Europe that can compete with the State of New York in the richness of its beets. If a factory, constructed on the best approved modern principles, and with every facility for converting the whole of the sugar into marketable form, could be supplied with such beets as were grown in the State of New York during the season of 1897, it would be capable of placing upon the market 240 pounds of pure granulated sugar for every ton of 2,000 pounds of beets entering into manufacture. When, in addition to these facts, are considered the cheapness of fuel, the abundance of labor, the proximity of markets, and the importance of the dairy industry in its relations to the refuse of the factory as a feed, it is seen that there is no place in the United States which offers more favorable inducements for the development of the industry.

ELEVATION OF REGIONS OF NEW YORK SUITED TO BEET CULTURE.

A contour map of the State of New York, showing the elevations above tide water, is found in the fifth annual report of the meteorological bureau and weather service of the State for 1893. The elevation in the region of the Catskills in some places reaches an altitude of 3,000 feet. Immediately west of this mountainous region, and extending to Binghamton on the south and almost across the State through the south central portion, there is a large area in which the average elevation is 1,000 feet. In the southwestern portion of the State there is a considerable area the elevation of which is 1,500 feet. The region of the Adirondacks and the northeastern portion of the State has various elevations, but as these regions are probably too far north for successful beet culture they do not interest us here. Starting from Albany with an average elevation of 100 feet and following the course of the New York Central Railway, we pass through an area a large portion of which is below 500 feet in elevation. From Rome through Syracuse and as far west as Lyons the average elevation is less than 500 feet, with the exception of small areas. From Lyons to Buffalo the average elevation is above 500 and less than 1,000 feet. Immediately along the shores of Lake Ontario the average elevation is less than 500 feet. Passing to the south near Rochester, along the Genesee Valley, is a considerable area below 500 feet in elevation.

An interesting description of the physical contour of the State is given in the report mentioned above as taken from the work of Prof. Arnold Guyot. This description is as follows:

> The following outline of the orography of New York is substantially as given by Prof. Arnold Guyot. Further details are exhibited by the accompanying relief map.

The mass of the State is a triangular table-land elevated 1,500 or 2,000 feet above the ocean, and may be considered the northeastern extremity of the plateau which, in this latitude, forms the western half of the Appalachian system. The natural limit of this belt toward the west and north is the large depression of Lakes Erie and Ontario, and which continues down the course of the St. Lawrence River to the ocean. In the east the table-land is terminated by the deep valley occupied by Lake Champlain and the Hudson River, while southward the highlands extend without interruption into Pennsylvania. The eastern edge along the Hudson and Champlain valleys is formed by a series of mountain chains more or less isolated from each other, and bearing the highest summits in the State. They are: The Highlands, which cross the Hudson at the limit of the coast region; the Shawangunk and Catskill mountains, on the western bank of the river, and the system of the Adirondacks, covering the territory between the St. Lawrence and Champlain valleys. Within this eastern wall the true mountain chains cease, but the remainder of the plateau is indented by numerous valleys, the bottoms of which are generally several hundred feet below the common level, and which are separated by high ridges. A remarkable feature is the deep transversal cut which forms the valley of the Mohawk and Lake Oneida, opening a channel from the low country of the Lake region to the Hudson valley, and thus dividing the main plateau into the distinct masses of the Appalachian and Adirondack systems.

A subdivision of the central or Appalachian highlands is due to the deep channel of Seneca Lake, extending from the plains bordering Lake Ontario southward to the valley of the Susquehanna. The two sections of the highlands thus separated are here designated as the eastern and western plateaus, the former extending from the central lakes to the Hudson Valley, and the latter westward from the central lakes to the depression of Lake Erie.

North Dakota.

Only four samples were received from North Dakota, the average weight of which was 28 ounces, and the mean percentage of sugar in the beet 10.5. On account of the low content of sugar, purity coefficients were not computed.

No report has been received from the director of the North Dakota station in regard to any work which has been carried on by that station. The data of the four samples received are likely to be misleading, as it is evident that North Dakota is capable of producing very much better beets than are indicated by the data in the analytical tables.

North Carolina.

By consulting the map it may be seen that there are many localities in North Carolina where the thermal conditions are favorable for the growth of high grade beets. It is doubtful, however, whether upon the summits of the Allegheny Mountains, where these conditions exist, a sufficient area of suitable soil could be secured to warrant the expectation of establishing successfully a beet-sugar industry in that State.

Only seven samples were received from North Carolina by the Department of Agriculture. The mean weight of these samples was 23 ounces, and the mean percentage of sugar in the beet 9.1. On account of the

low polarization of the samples, it was not deemed necessary to make a computation of the coefficient of purity.

No analyses were made at the laboratory of the experiment station of North Carolina during the year, although the director of the station has been much interested in the work, and proposes to continue it another season.

Ohio.

Sixty-eight samples of beets grown in Ohio were received at the Department laboratory for analysis. The mean weight of these beets was 22 ounces, the mean content of sugar 13.8 per cent, and the mean coefficient of purity, 79.1. Grouped by belts into northern, central, and southern, the character of the beets grown in Ohio and analyzed at the Department of Agriculture is shown in the following table:

Summary of analyses of beets from Ohio, by belts.

Belts.	Number of samples.	Average weight.	Sugar in beets.	Purity coefficient.
		Ounces.	*Per cent.*	
Northern belt	42	21	14.1	79.9
Central belt	19	23	13.6	78.5
Southern belt	7	26	12.7	75.7

It will be seen from the above that the northern belt of the State produced the best beets, both in content of sugar and purity, and in this respect the data obtained by the Department corroborate in every particular those secured by the Ohio Experiment Station mentioned below. It is evident, from a consideration of the two sets of data, that the northern portion of Ohio offers favorable inducements, both for the culture of the beet from an agricultural point of view and by reason of cheapness of fuel and the facilities of transportation from the manufacturing point of view. It is evident, however, that the central and southern parts of the State, as is the case with Indiana and Illinois, should not be exploited with the purpose of investing money in the beet-sugar industry until the available localities in the northern regions are entirely occupied.

With the cooperation of the Department of Agriculture, the agricultural experiment station of Ohio distributed a large quantity of seed to farmers in that State, and from the seed so distributed 607 samples of beets were forwarded to the station and analyzed. The results of the analyses by counties are given in the following table:

EXPERIMENTS CONDUCTED BY THE OHIO AGRICULTURAL EXPERIMENT STATION.

Summary of results of sugar-beet investigation for Ohio, 1897.

County.	Number of samples analyzed.	Average weight of beets.	Sucrose in juice.	Purity coefficient.	County.	Number of samples analyzed.	Average weight of beets.	Sucrose in juice.	Purity coefficient.
		Grams.	*Per ct.*				*Grams.*	*Per ct.*	
Ashland	4	831	12.7	76.0	Marion	7	555	12.4	77.5
Ashtabula	2	679	14.9	82.8	Medina	6	947	13.9	76.2
Auglaize	9	1,128	14.4	77.0	Mercer	11	1,119	13.2	77.2
Belmont	1	660	16.6	86.9	Miami	12	773	12.6	75.9
Champaign	1	825	13.2	77.6	Montgomery	3	755	11.8	73.5
Clark	11	610	14.1	78.7	Muskingum	5	566	14.4	78.2
Columbiana	1	610	18.4	83.6	Ottawa	13	694	15.7	78.8
Coshocton	4	860	12.9	72.9	Paulding	9	802	15.6	80.0
Crawford	7	1,095	13.8	77.1	Perry	1	127	19.1	80.9
Cuyahoga	4	894	12.9	75.5	Pickaway	1	710	16.5	81.6
Darke	44	864	13.3	76.9	Pike	1	595	14.0	77.8
Defiance	23	851	13.7	77.9	Portage	2	1,554	9.3	a69.7
Delaware	4	559	14.9	79.3	Putnam	19	958	13.1	76.5
Erie	1	1,406	15.0	80.6	Richland	2	496	16.6	83.4
Fairfield	5	599	12.8	74.9	Ross	31	697	13.5	76.6
Fayette	2	620	14.6	78.9	Sandusky	3	812	14.8	79.6
Franklin	5	524	15.3	80.0	Seneca	10	762	14.8	77.5
Fulton	24	1,065	14.1	79.2	Shelby	8	607	14.0	80.0
Geauga	6	694	16.3	84.8	Stark	8	712	15.3	80.8
Greene	11	1,285	9.9	66.8	Summit	28	684	14.7	80.2
Hardin	4	796	12.1	74.2	Tuscarawas	4	865	14.8	79.1
Henry	33	810	15.3	80.9	Union	2	1,077	15.9	80.6
Highland	1	840	13.2	68.4	Van Wert	21	1,064	12.5	73.1
Hocking	1	1,521	7.2	a59.0	Wayne	97	787	13.9	80.7
Holmes	6	680	13.6	81.0	Williams	3	979	16.2	80.2
Huron	1	303	16.0	76.1	Wood	26	777	14.4	78.3
Knox	4	642	15.9	81.9	Wyandot	1	605	15.1	79.8
Lake	5	789	14.9	82.7					
Licking	11	562	11.9	74.9	Southern section	69	892	12.8	75.3
Logan	2	779	12.8	80.0	Middle section	146	924	13.9	78.0
Lorain	1	520	16.0	81.2	Northern section	392	834	14.3	79.4
Lucas	32	889	14.3	78.5					
Madison	5	711	14.3	76.8	Entire State	b607	867	14.0	78.7

a Not included in average of State.
b Some samples were received without name and address of grower.

It will be observed from the above table that the number of samples analyzed was 607. Only 554, however, of these samples figure in the averages for the State, the others having been rejected for computing purposes by reason of certain abnormalties which they presented. The Ohio results are exceedingly encouraging from every point of view, with the exception of purity alone. The average weight of the beets was 867 grams, equivalent to 30.6 ounces. The average per cent of sugar in the expressed juices was 14 per cent, equivalent to 13.3 per cent in the beet, and the average coefficient of purity of the juices was 78.7. The most interesting grouping of the samples is shown at the end of the table, particularly so because in the State of Ohio the most favorable theoretical thermal conditions prevail only in the northern counties. The grouping of the total number of samples into three portions, representing the northern, central, and southern sections of the State, shows in a convincing manner the effect of thermal conditions on the sugar content of the beet. The northern counties furnished 392 samples, with an average weight of 834 grams, equivalent to 29.4 ounces, with

an average percentage of 14.3 per cent of sugar in the juice, equivalent to 13.6 per cent in the beet, with an average coefficient of purity of 79.4. The middle section furnished 146 samples, with an average weight of 924 grams, equivalent to 32.6 ounces, with a mean content of sugar of 13.9 per cent in the juice, or 13.2 per cent in the beet, and a mean coefficient of purity of 78. The southern section furnished 69 samples, with an average weight of 892 grams, equivalent to 35 ounces, a mean percentage of 12.8 per cent of sugar in the juice, or 12.2 per cent in the beet, and a mean coefficient of purity of 75.3.

It is seen by the above that there is marked improvement, both in the percentage of sugar and the purity of the juice, in the beets in Ohio as we advance from its southern to its northern border.

The results of the work of the experiment station of Ohio have already been published as Bulletin No. 90 of that station, and interesting details connected with the above data can be found therein. The bulletin also contains interesting maps, showing isothermal lines and conditions of precipitation in the State. The remarks of the authors of the bulletin, namely, Mr. A. D. Selby and Mr. L. M. Bloomfield, on the general character of the results are interesting and are found below:

Taken as a whole, these analyses seem to indicate that beets of good quality may be grown in most counties of the middle and northern sections of Ohio, and, further, that many portions of the southern section may be adapted to sugar-beet growing, although on the whole less promising than more northerly districts. The analyses from Fayette, Pickaway, Ross, Pike, and Perry counties appear encouraging. The sugar content in Ross County is decidedly reassuring, though the purity is slightly below the standard. Judging by the samples, this might have been greatly improved by more careful culture and better selection of typical specimens. The unfavorable results in Greene and Montgomery counties are not taken to indicate what may really be done in these counties. For the southern section, and particularly the valley districts, further trials should be made. Close planting should be practiced on rich lands.

For the middle section, as a whole, good sugar beets may apparently be grown when growers have learned what to avoid in planting and culture. The low averages in samples from Mercer, Hardin, and Coshocton counties may not certainly be taken as conclusive evidence of conditions unfavorable to sugar-beet culture. Those reported from sandy soils in Mercer County show a fair purity. The results from Belmont, Muskingum, and Tuscarawas counties point to better things in the eastern counties than previously anticipated. More trials in this region another year are certainly warranted by these analyses.

As anticipated from previous trials, it is the northern section which makes the most favorable showing as a whole. Samples were received from every county of the northern section except Trumbull, Mahoning, Hancock, and Allen. A sample was received from Columbiana County after the tables had been completed. While the lake shore district shows to good advantage here, the counties situated along the summer isothermal of 70° F. are but slightly, if at all, inferior, though represented by a much larger number of samples. Ottawa County gives a low purity with a high sugar content, 15.7 per cent. It will be noted that a large number of samples is not conducive to extremely high averages in the tables.

In fact, practically all the counties of the State show a rather high sugar content, 14 per cent in juice when all are averaged, and it is to the coefficient of apparent purity that we must direct our attention to discover differences. Under all the circumstances an average purity of 78 and above may be taken as fairly satisfactory for the present year's analyses.

It is to be borne in mind, when these results are considered, that the percentages were obtained for the most part in comparatively fresh samples, from which only the leaves had been removed. Topping the beets, as for factory use, was not encouraged, owing to the risk of water loss by evaporation. This has led, possibly, to lower percentages than where beets were topped and sent considerable distances by mail. While the actual sugar content would be but slightly, if at all, reduced by loss of water, the apparent sucrose per cent would be changed.

Oklahoma.

Only one sample of beets was received at the laboratory of the Department of Agriculture from Oklahoma. The average weight of the beets composing the sample was 10 ounces, the mean percentage of sugar in the beets 11.8, and the coefficient of purity, 72.5. The director of the agricultural experiment station has submitted the following report of the analyses of 21 samples, showing a mean percentage of sugar in the juice of 12, and in the beet of 11.4, and a mean coefficient of purity of 65.3. The mean coefficient of purity as obtained at the experiment station of Oklahoma is phenomenally low. These data, taken in connection with the climatic conditions which prevail in that Territory, are sufficient to indicate that there is no prospect of establishing a beet-sugar industry in Oklahoma.

RESULTS OF EXPERIMENTS IN OKLAHOMA.

Seed and culture directions were sent to farmers in each county, and the number of requests for seed quickly exhausted the available supply. But twenty-four reports were received and twenty-one authentic samples examined. Of the three total failures reported, one is stated as due to flood, another to drought, and the third to hail. The yield, judging from the vague and indefinite reports which I have been able to secure, varied greatly. It seems that in many cases the seed was sown too far apart in the drills and that but little regard was paid the culture-directions sent out. In general, a poor stand was secured, and the majority of those reporting are not enthusiastic as to the prospects of the sugar-beet industry in Oklahoma.

I inclose a tabular statement of the results of analyses of beets. The low coefficient of purity of the juice is especially noticeable.

Analyses of sugar beets grown in Oklahoma Territory, 1897.

County.	Sugar in juice.	Coefficient of purity.	County.	Sugar in juice.	Coefficient of purity.
	Per cent.			*Per cent.*	
Canadian	9.3	53.1	Logan	9.3	58.1
Do	13.0	66.3	Oklahoma	14.0	78.6
Do	10.1	62.7	Pawnee	12.2	68.5
Cleveland	13.0	74.3	Payne	17.7	72.5
Custer	13.9	68.1	Do	11.9	54.3
Garfield	12.6	67.3	Do	11.8	64.3
Kingfisher	14.9	66.2	Do	11.8	63.1
Lincoln	10.8	73.0	Do	8.4	52.1
Do	10.8	57.7	Pottawatomie	12.8	61.2
Do	13.9	81.8			
Do	10.1	60.1	Average	12.0	65.3
Logan	9.6	68.6			

Oregon.

No samples of beets were received at the Department from the State of Oregon during the season. Previous analyses of beets received from that State have shown uniformly a high content of sugar and a

high coefficient of purity. The agricultural experiment station of Oregon for several years has devoted a great deal of time and attention to the study of the sugar-beet industry in that State and published valuable reports on the subject. Mr. G. W. Shaw has prepared a résumé of the work of the station and of the Department, which contains the summaries of the work done, with various comments on the data obtained. This report is given below.

RESULTS OF EXPERIMENTS IN OREGON.

In his notes on the analyses of beets for the season of 1891, Dr. H. W. Wiley, chemist of the United States Department of Agriculture, said: "The samples from Oregon are uniformly rich in quality, and if they truly represent the capabilities of the State there is certainly a bright future for the sugar-beet industry on that portion of the Pacific coast." This was said relative to a series of 33 analyses made at the United States Department of Agriculture, which gave the following average results: weight, 644 grams; sugar in the juice, 14.5 per cent; purity, 82.2.

It was to obtain a decided answer to the question, "Does Oregon possess the requisite conditions for the manufacture of sugar from beets?" that the writer, as chemist of the Oregon Experiment Station, began a series of experiments with beets in 1891, which were continued in 1892 and again in 1897. The results of these investigations are here briefly set forth, more detailed account of which may be had by applying to the station for Bulletin No. 44.

The sugar beet does not differ from other plants in requiring certain conditions of climate and soil to give favorable results. In foreign countries both of these questions have been pretty satisfactorily settled, but in some parts of the United States the plant seems to thrive under very different conditions than obtain in foreign countries. Notably is this true concerning the rainfall, as is illustrated in the case of California and Utah, as well as in the experimental culture in Oregon, as will appear later; hence foreign countries can not be taken as representing the only conditions under which the root will thrive. However, it does there thrive and these conditions can by no means be ignored. It also thrives, and that splendidly, in our own California, hence her conditions can not be disregarded in a consideration of this question. Let us examine Oregon's condition of climate and soil that, if possible, we may obtain some a priori ideas on these lines.

The season for the growth of beets may be divided into three periods—that of germinating, that of plant formation, and that of sugar storing. The following is a comparative table showing the temperature averages for Germany and certain parts of Oregon during these periods:

Average temperature for periods of growth.

Period of growth.	Average temperature.			
	Foreign.	Eastern Oregon.	Willamette valley.	Southern Oregon.
First	49.1	56.0	52.5	53.3
Second	63.3	65.0	64.4	64.5
Third	56.3	64.5	63.3	54.8

Taking as a basis Dr. McMurtrie's mean isotherm for sugar-beet culture at 70° for June, July, and August, Dr. Wiley, in his report upon beet culture, gives a map of the United States, showing 100 miles on each side of this isotherm, within which area favorable results may be looked for.

It is in the rainfall of the State that we find the greatest seeming deviation from those portions of the world which are taken as typical beet-producing regions. This seeming difference should not be considered as a too serious drawback, nor would it appear so to those acquainted with all the conditions. The average amount of rainfall does not differ much from that of the beet-growing regions of other countries, yet it is not so evenly distributed. It must be borne in mind, however, that the soils of Oregon are much different with respect to their retentiveness of moisture, and that for all our crops the necessary moisture nearly all falls during the "wet season," and for this reason we do not usually consider the monthly rainfall as bearing so close relation to the crops as it does in most other States, but rather are wont to consider the seasonal precipitation as the more important factor. In this respect ours is similar to the condition which obtains in our sister State, California, in which the beet industry has reached a high state of development.

Champion and Pellet consider phosphoric acid as an indispensable base for the formation of sugar in the beet. They classify the order in which the plant food is indispensable as follows: (1) Phosphoric acid, (2) lime, (3) nitrogen, (4) potash.

It is foreign to our purpose to discuss, at this time, the soils of Oregon to any length, but in connection with the last statement I desire to direct attention to the fact that the soils of Oregon are well—yes, abundantly—supplied with phosphoric acid; that they surpass those of France in lime and equal them in potash. Below are contrasted analyses of some of the French sugar-beet soils with those of the natural divisions of this State and those of California. These results, I think, speak for themselves, and need no further comment.

Average comparative composition of soils.

Analysis of fine earth.	France.		Oregon.			California.
	Somme.	Nord.	Eastern.	Willamette Valley.	Southern.	
Insoluble matter	81.80	82.50	66.59	65.18	62.45	67.88
Soluble silica			13.12	5.02	8.74	8.96
Potash (K_2O)	.06	.14	.43	.23	.34	.64
Soda (Na_2O)	.09		.22	.18	.21	.28
Lime (CaO)	.51	.42	1.22	.83	2.22	1.08
Magnesia (MgO)	----	----	.75	.79	.80	1.49
Manganese (Mn_3O_4)	----	----	.10	.08	.25	.06
Iron (Fe_2O_3)	2.88	2.18	10.69	16.45	15.35	15.02
Alumina (Al_2O_3)	7.24	8.62				
Sulphuric acid (SO_3)	----	----	.04	.03	.01	.05
Phosphoric acid (P_2O_5)	.09	.08	.14	.21	.13	.08
Carbonic acid (CO_2)	.40	.70	----	----	----	----
Water and organic matter	5.60	4.84	6.21	10.77	9.52	4.40
Other matter	1.85	1.52	----	----	----	----
Humus	----	----	1.44	1.63	2.25	.75

Measured, then, by the foreign conditions as to temperature and the California conditions as to rainfall, and with a soil amply supplied with all the elements necessary to produce abundant crops, Oregon would certainly seem favored with all the requisites for success in beet culture.

The analyses made at the station during the season of 1891–92 may be summarized as follows:

County averages for 1891.

County.	No.	Sugar.	Purity coefficient.	County.	No.	Sugar.	Purity coefficient.
Benton	39	12.30	74.12	Marion	1	15.99	78.38
Clackamas	7	14.55	77.30	Polk	1	14.72	78.08
Columbia	1	13.74	79.42	Union	3	15.84	79.89
Douglas	9	12.99	73.45	Washington	11	13.96	78.79
Jackson	3	18.93	80.99	Yamhill	1	10.73	76.64
Lane	16	14.32	79.95				
Linn	5	13.54	79.91	Average	....	14.13	78.08

An examination of the results reveals that the analyses had a wide range, viz: From 6.77 per cent to 22.44 per cent sugar in the juice. Of the 95 analyses made, 8 fell below 10 per cent; 76 showed over 12 per cent, and 37 over 14 per cent sugar. An average of 81 analyses for the Willamette Valley shows 13.76 per cent sugar and a purity coefficient of 77.89; the average beet weighing a little over 1¼ pounds, while an average of 10 analyses of beets from southern Oregon showed 13.38 per cent sugar with a little larger beet. But this does not really show the capabilities of this section of the State, as will appear later, for there were quite a number of immature beets included in this average.

Experiments of 1892.—For the investigations of 1892 the following varieties were used, Desprez's Early Rose, Vilmorin's Improved, Kleinwanzlebener, and White Imperial, all of which are favorite kinds, the first being much used in California. Unfortunately the seed was delayed in reaching us, so it could not be distributed to the farmers as early as it should have been to secure the best results. Had the seed reached us in due time, it could have been put into the ground in April, for at that time there was favorable weather for seeding, but by the time the seed had been distributed cold weather set in and continued till May, after which the weather became very dry, rendering the conditions for a fair trial very unfavorable.

The rainfall for the season was below the normal and reports all read "very dry," "extraordinarily dry," "weather very unfavorable." In fact, nearly all the beets in the eastern portion of the State failed to mature, and in many instances the seed failed to germinate. So far as the season's climate is concerned, then, the experiments were greatly handicapped and we were "in pursuit of knowledge under difficulties."

The cultivation for this season was the same as for the previous year, except that the rows were placed 20 inches apart.

Owing to the disturbed condition of the experiment, the results are doubtless poorer than would have been the case had the season been one of more nearly normal conditions. Still, the results confirm the conclusions of the previous year, that Oregon possesses the conditions necessary for the production of excellent beets for the purpose of beet-sugar manufacture.

Expressed by counties the averages are as follows:

Averages for 1892 by counties.

County.	Number of analyses.	Average for 1892.	Purity coefficient.	County.	Number of analyses.	Average for 1892.	Purity coefficient.
Benton	17	12.80	86.50	Polk	5	14.50	73.30
Clackamas	1	15.10	87.83	Union	7	19.80	87.33
Douglas	9	15.20	81.15	Washington	10	15.50	78.79
Jackson	1	15.00	84.74	Yamhill	5	13.70	82.83
Lane	2	15.20	84.05	Josephine	2	15.70	88.00
Lincoln	3	16.20	83.00	Wasco	1	21.10	90.50
Linn	1	17.10	73.74	Malheur	1	20.20	84.90
Marion	2	13.80	74.60				

The average of all analyses for the State was 15.7 per cent sugar in the juice, with a purity coefficient of 78.08, against 13.75 per cent and a purity of 77.57 for the previous season. Out of the 65 analyses made, only 11 indicated less than 12 per cent sugar in the juice, and 41 samples indicated over 14 per cent, the extremes being 9.4 per cent and 23.8 per cent. The average for the different natural divisions of the State were as follows:

	Per cent.
Willamette Valley, 44 samples	14.7
Eastern Oregon, 11 samples	19.2
Southern Oregon, 10 samples	15.1

While from 1893 to 1897 no definitely outlined experiments have been conducted, yet the station has furnished more or less seed to various parties who have sent the beets to be analyzed. In other cases beet seed has been furnished by other parties, and analyses have been made in all cases when beets were forwarded to the station. The average of the results of 23 analyses made since 1892 shows 15.05 per cent sugar in the juice and a purity coefficient of 89.8.

Average of all results.—Let us now collect the results to 1897 which have been thus separately set forth. In the same table I beg to include the averages from analyses made at Washington, D. C., by the United States Department of Agriculture. These last-mentioned results really indicate a little too high, probably about 10 per cent, on account of the time that necessarily elapsed between harvesting and analyzing, which would result in a loss of water.

Expressed by counties the averages are as follows:

Average of all analyses for each county.

County.	Number of analyses.	Average of analyses made at station.	Purity coefficient.	Number of analyses.	Average for United States Department of Agriculture.	Purity coefficient.
Benton	42	12.57	79.63	5	14.34	82.8
Clackamas	8	15.62	78.76	3	15.36	84.2
Columbia	1	13.74	79.42	3	15.30	81.7
Coos	0	.....	.....	5	14.56	82.6
Douglas	18	14.10	77.98	1	17.74	84.3
Jackson	4	17.93	81.00	1	18.94	83.9
Lane	18	14.42	80.19	6	14.24	85.4
Lincoln[1]	.....	.....	.....	.....	.....	.....
Linn	6	14.13	73.43	1	14.15	79.4
Marion	4	15.17	74.60	2	14.15	81.1
Polk	16	14.54	74.10	1	12.10	79.8
Union	30	18.61	85.10	2	14.35	81.8
Washington	2	15.29	80.98	3	12.49	80.7
Yamhill	7	12.87	82.76	0	.....	.....
Josephine	2	15.70	81.21	0	.....	.....
Wasco	1	21.10	90.50	0	.....	.....
Malheur	1	20.20	83.44	0	.....	.....
Sherman	0	.....	.....	1	13.55	72.2
Umatilla	0	.....	.....	1	15.12	80.9
Multnomah	1	16.90	76.80	.....	.....	.....

[1] Averaged with Benton County.

If we omit from the average those beets which were immature or overgrown, the averages for the State will be:

	Sugar.	Purity coefficient.
Season of 1891	14.3	78.2
Season of 1892	15.9	81.4
Since 1892	15.0	84.8
Mean	15.0	81.5

During the season just ended, 1897–98, the experiments were continued, but were limited for the most part to those portions of the State which seemed to offer not only the best conditions for growing beets, but also presented other favorable economic conditions, for unless the requisites for the manufacture of sugar can be had as well as the beets, it is useless to expend labor in an attempt to show that we can grow good beets. In these experiments the conditions were not particularly favorable—indeed, were adverse, inasmuch as the ground was entirely prepared in

the spring and the seed was late. The results obtained in the localities selected are given below:

County.	Weight.	Sugar.	Purity coefficient.
	Grams.	*Per cent.*	*Per cent.*
Washington	395	15.2	85.9
Clackamas	508	13.8	83.4
Union	477	17.5	88.4
Jackson	437	15.6	81.0
Miscellaneous	512	14.1	85.8

PENNSYLVANIA.

Fifty-nine samples of beets grown in Pennsylvania were received at the Department of Agriculture laboratory for analysis. The mean weight of the beets in the samples was 18 ounces, the mean content of sugar in the beet 13.8 per cent, and the mean coefficient of purity, 79.5. The size and sugar content of the samples received from the whole State were satisfactory, but the coefficient of purity falls a little below the minimum standard.

The samples received may be divided, for the purposes of study, into two sets, namely, those from counties lying in and north and west of the favorable thermal belt, and second, the counties lying south and east of that belt. Collected by counties, the samples divided according to the above classification show the following data:

Counties of Pennsylvania above and below isothermal line 70°.

County.	Number of samples.	Average weight.	Sugar in the beets.	Coefficient of purity.
Above 70°.		*Ounces.*	*Per cent.*	
Allegheny	13	18	13.8	77.0
Crawford	3	25	13.9	75.3
Elk	2	16	13.0	77.4
Erie	7	28	15.8	82.5
Mercer	2	34	15.4	83.7
Potter	1	18	18.0	81.1
Union	1	10	19.6	.....
Lawrence	2	16	16.8	79.9
Averages, etc	31	21	14.8	78.9
Below 70°.				
Cumberland	22	12	12.2	79.6
Lebanon	1	24	14.4	79.0
Perry	2	31	15.7	82.2
York	3	25	13.9	80.2
Averages, etc	28	15	12.7	79.8

It will be seen that the 31 samples coming from the counties lying in and to the north and west of the favorable thermal belt have an average weight of 21 ounces, a mean content of sugar in the beet of 14.8 per cent, and a mean coefficient of purity of 78.9. The 28 samples coming from counties lying south and east of the favorable thermal belt have a mean weight of 15 ounces, a sugar content in the beet of 12.7

per cent, and a mean purity of 79.8. With the exception of the coefficient of purity, the influence of the more favorable thermal conditions is easily distinguished.

Of the counties in Pennsylvania furnishing the most data may be mentioned Allegheny, with 13 samples, having an average weight of 18 ounces, a mean content of sugar in the beet of 13.8 per cent, and a mean purity of 77. Cumberland County, in the southern part of the State, sent 22 samples, having a mean weight of 12 ounces, a mean content of sugar in the beet of 12 per cent, and a mean purity of 79.6. Erie County sent 7 samples, having a mean weight of 28 ounces, a mean content of sugar in the beet of 15.8 per cent, and a mean purity of 82.5. The samples from Erie County are decidedly the most favorable, and this is to be expected, since Erie County has conditions of soil and climate which are entirely analogous to those pervading the New York area from Albany to Buffalo.

Attention has been called before to the mountainous character of a large part of the State of Pennsylvania, even where favorable thermal conditions prevail. It is evident, however, that in the northern and western portions of the State, where suitable soil can be found, the culture of the sugar beet may be introduced under the most favorable conditions, and with every prospect of success.

EXPERIMENTS CONDUCTED BY THE AGRICULTURAL EXPERIMENT STATION.

The agricultural experiment station of Pennsylvania cooperated with the Department of Agriculture in the investigation of the beet-sugar work, and has published the results of its work in Bulletin No. 40 of that station. For details of the analytical work and of the observations made by the director of the station the reader is referred to the bulletin mentioned. In discussing the analyses Director Armsby says:

> Of the 69 samples reported upon in the above table, 55 (or 80 per cent) showed over 12 per cent of sugar in the beet. Thirty-four samples (or 49 per cent) showed a coefficient of purity of over 80. Thirty-two out of the total number (or 46 per cent) showed over 12 per cent of sugar and also a purity coefficient of over 80. In view of the fact that practically all of the beets were raised by farmers who had had no experience in the culture of this plant for sugar, the results must be regarded as decidedly favorable so far as the quality of the beets is concerned.
>
> In 40 cases out of the whole number we have data regarding the average weight of the beets. Of these 40 samples, 14 (or 35 per cent) weighed between 0.80 and 1.35 pounds, 18 (or 45 per cent) were below 0.80 pound in weight, and 8 (or 20 per cent) were above 1.35 pounds. It thus appears that, as a rule, the size of the beets was rather small.
>
> Thirty-four of the experimenters reported the yield of beets. In most cases the yield was calculated from that of a comparatively small area, and in many cases there is evidence that the results may be considerably in error. Taking them as they stand, however, 10 (or 29 per cent) reported a yield of over 15 tons per acre, 2 (or 6 per cent) a yield of between 10 and 12 tons per acre, and 17 (or 50 per cent) a yield below 10 tons per acre. It thus appears that while, as stated above, the general quality of the beets was good, the yield was rather small.

As stated above, 32 of the samples showed more than 12 per cent of sugar with a purity coefficient of more than 80. Of these 32 experiments, 7 (or 22 per cent) reported a yield of over 10 tons per acre, 4 (or 13 per cent) a yield of between 8 and 10 tons per acre, 7 (or 22 per cent) a yield of less than 8 tons per acre, while 14 (or 44 per cent) did not report the yield. These figures confirm those given above in showing that the yield was, as a whole, rather small.

Rhode Island.

Only 2 samples were received from Rhode Island, and no deductions of any value can be made from such limited data. The average weight of the beets composing the samples was 21 ounces, the mean percentage of sugar therein 11.9, and the mean purity 74.2. These data of course are far from encouraging, but there are reasons for supposing that the climate of Rhode Island is favorable to the production of a much richer beet. The available area for cultivation in beets in Rhode Island is small, and it may not be worth while to prosecute the experimental work. Nevertheless, it is suggested that it might be profitable for the agricultural experiment station of Rhode Island to study the subject to a greater extent.

South Carolina.

Thirteen samples were received at the Department of Agriculture from South Carolina. The mean weight of the samples was 17 ounces, the percentage of sugar in the beet 9.9, and the mean purity 79.9. These data, taken into consideration with the latitude and thermal conditions, indicate that there is no prospect of South Carolina becoming a sugar-producing State.

South Dakota.

Only 5 samples of beets grown in South Dakota were received at the Department for analysis. The mean weight of the beets composing these samples was 17 ounces, the mean content of sugar in the beet 15.1, and the mean purity coefficient 83.2. These data are favorable, but too meager for the basis of any definite conclusions.

Experiments by the Agricultural Experiment Station of South Dakota.

Extensive investigations in cooperation with the Department of Agriculture were carried on by the South Dakota station during the past season. The whole number of samples analyzed at the South Dakota station was 337. For convenience of classification they are grouped according to the different regions in the State, and by counties in the regions as is shown in the following table:

Averages by counties and regions.

[From report of Jas. H. Shepard, Chemist of Experiment Station.]

Region and county.	Number of samples.	Tons per acre.	Per cent stand.	Average weight.	Sugar in beets.	Purity coefficient.	Ash in the juice.
BIG STONE LAKE REGION.				*Grams.*	*Per cent.*		
Roberts County	3	24.6	90	387	15.3	88.0	0.85
Grant County	7	16.4	71	397	13.9	87.5	.90
Region averages	.....	20.5	81	392	14.6	87.8	.88
UPPER SIOUX RIVER REGION.							
Codington County	4	15.7	60	473	12.9	85.1	.87
Deuel County	4	8.5	83	423	14.5	89.2	.60
Kingsbury County	14	23.1	85	359	14.0	86.2	1.00
Moody County	5	14.1	79	431	14.2	87.8	1.15
Lake County	4	16.6	72	424	13.8	81.2	1.09
Brookings County	26	19.8	74	455	13.4	86.7	.88
Minnehaha County	24	20.2	77	423	15.2	86.1	1.08
Region averages	.....	16.9	76	427	14.0	86.0	.95
LOWER SIOUX RIVER REGION.							
Lincoln County	9	16.4	81	402	15.0	84.8	1.17
Turner County	9	18.2	55	437	14.5	85.1	1.12
Hutchinson County	1	19.5	80	333	19.5	88.4	1.20
Bonhomme County	10	17.5	77	449	15.4	87.2	.99
Clay County	18	30.5	88	470	14.7	86.2	1.15
Yankton County	22	19.7	77	498	14.6	86.0	1.03
Union County	18	19.3	79	388	15.2	88.5	.81
Region averages	.....	20.2	77	425	15.6	86.6	1.06
CENTRAL JAMES RIVER REGION.							
Miner County	4	21.5	47	329	14.5	84.6	2.06
Sanborn County	7	14.2	64	373	15.5	87.4	.92
Davison County	9	30.1	81	470	14.8	86.4	.91
McCook County	2	22.5	75	423	15.0	89.0	1.03
Region averages	.....	22.1	67	399	14.9	86.9	1.23
UPPER JAMES RIVER REGION.							
Marshall County	3	.....	90	322	13.7	85.6	.76
Brown County	19	15.1	61	364	13.3	81.7	1.06
McPherson County	2	26.3	100	314	18.3	85.3	.73
Edmunds County	3	17.7	75	349	15.1	84.3	1.18
Day County	10	14.5	69	367	13.9	88.3	.91
Clark County	8	22.8	75	351	13.9	87.2	1.08
Spink County	5	19.1	75	362	15.5	89.1	1.09
Beadle County	13	33.6	77	475	14.5	86.8	1.06
Faulk County	2	12.8	95	304	18.0	89.5	1.28
Hyde County	2	14.3	50	488	14.6	84.7	1.00
Hand County	2	11.8	90	259	16.8	81.4	1.27
Region averages	.....	18.8	78	360	15.2	85.8	1.04
UPPER MISSOURI RIVER REGION.							
Campbell County	2	12.3	55	427	17.7	89.2	1.20
Walworth County	2	16.6	95	389	14.9	84.8	1.11
Potter County	4	17.2	59	409	15.9	88.0	1.12
Sully County	1	12.5	90	525	14.3	86.7	1.12
Hughes County	3	8.3	55	399	14.8	85.3	1.09
Region averages	.....	13.4	71	430	15.5	86.8	1.13
CENTRAL MISSOURI RIVER REGION.							
Jerauld County	6	11.0	76	290	15.3	84.5	1.28
Buffalo County	2	44.0	85	379	16.1	84.3	1.17
Brule County	7	17.2	75	375	16.2	82.4	1.38
Aurora County	5	14.7	73	394	16.6	86.7	1.10
Douglas County	2	16.8	70	286	16.4	87.8	.99
Charles Mix County	3	23.9	85	394	14.8	83.2	1.25
Region averages	.....	21.3	77	336	15.9	84.8	1.19

Averages by counties and regions—Continued.

Region and county.	Number of samples.	Tons per acre.	Per cent stand.	Average weight.	Sugar in beets.	Purity coefficient.	Ash in the juice.
WHITE RIVER REGION.				*Grams.*	*Per cent.*		
Presho County	1	45.0	.....	421	14.9	83.1	.90
Pratt County	1	33.0	100	445	14.3	82.0	1.07
Gregory County	1	.....	.....	263	16.4	80.8	1.22
Region averages	.....	39.0	100	376	15.2	82.0	1.06
BLACK HILLS REGION.							
Meade County	10	16.1	75	401	16.8	82.1	1.19
Pennington County	5	9.5	79	330	16.4	82.7	1.48
Custer County	1	10.0	80	67	14.8	78.0	.47
Fall River County	4	15.4	90	325	15.9	83.7	1.35
Region averages	.....	12.8	81	281	16.0	81.6	1.12
BUTTE REGION.							
Harding County	4	.....	35	343	20.7	86.0	1.30
Butte County	4	33.8	78	471	16.5	89.4	1.18
Region averages	.....	33.8	57	407	18.6	87.7	1.24
State averages	.....	21.9	77	383	15.5	85.6	1.09

From an inspection of the above data it is seen that the results of the experiments conducted by the station are quite encouraging. The mean average weight of the beets analyzed was a little below the normal; 383 grams, equivalent to 13.5 ounces. The mean content of sugar in the beets was 15.5 per cent, and the mean purity coefficient 85.6. The data for yield per acre are probably unreliable, as many reports of tonnage are given which are evidently erroneous, as, for instance, in Presho County, where a yield of 45 tons per acre is reported, and in Pratt County, 33 tons per acre, a quantity of beets which is not to be expected under the most favorable circumstances of growth. In so far as producing a crop of beets rich in sugar is concerned, the conditions in South Dakota seem to be extremely favorable. Attention, however, should be called to former statements that the farmers of this State will have to contend with the great difficulty of an early and sudden coming of winter. If, therefore, the industry should secure a hold, this will be the most important point in the agricultural part of the work to be considered, namely, the harvesting and preserving of the crop for manufacturing purposes. The high purity coefficients which obtain in South Dakota are especially encouraging. There is no other State which has equaled South Dakota in the purity of the juices of the beets. There is abundant reason found in the data published above to encourage the agricultural experiment station of the State to continue its work of investigation, and to attract the favorable attention of intending investors.

Texas.

The northwestern portion of Texas reaches an altitude where the thermal conditions become more favorable to beet production. It is not to be expected that the southern and western portions of the State will ever be seriously considered for this purpose.

Eleven samples were received from Texas at the Department of Agriculture laboratory, having an average weight of 22 ounces, a mean content of sugar in the beets of 12.6 per cent, and a mean purity of 76.5. All the counties represented were in the northern and western portions of the State except McLennan, which is in the center. There is reason to believe that on the high plateaus in the northwestern portion of the State, where irrigation is possible, the culture of the sugar beet might be introduced with considerable prospects of success.

A few analyses were made by the agricultural experiment station of Texas, and these are given below:

REVIEW OF THE WORK DONE BY THE AGRICULTURAL EXPERIMENT STATION OF TEXAS.

All of the seeds that we received for distribution in this State during the past season came to hand too late for proper planting in a State so far south as Texas. For this reason the dry season prevented a fair growth of the beets at an important period in their development, and the crops waited for the fall rains to develop size. These fall rains were accompanied by a small per cent of sunshine, resulting in a low sugar content. These conclusions are based upon the fact that where beets were planted late and irrigated, the sugar content was higher than when samples were grown by late fall rains and then sent us for analysis. Of course the extreme western portion of the State produced beets of high sugar content.

Results of experiments in Texas.

Name and address of persons from whom beets were received.	Section of State.	Laboratory number.	Brix.	Sucrose.	Purity coefficient.	Weight.	
						Lbs.	*ozs.*
R. B. Edgell, Clarendon, Donley County, Tex.	Panhandle ▭	1	16.8	11.88	70.68	1	10
D. W. Ruckston, Silverton, Briscoe County, Tex.	do	1	15.5	9.69	62.5	2	4
Do	do	2	17.0	11.02	64.82	2	6
Do	do	3	14.0	6.89	49.19	2	10
Do	do	4	13.2	7.98	60.91	3	11
R. L. Goble, Garrett, Ellis County, Tex.	Black Land Belt ▱	(*)	13.5	7.79	57.7	1	11
L. H. Carpenter, Silverton, Briscoe County, Tex.	Panhandle ▭	1	15.2	6.27	41.8	1	5
Do	do	2	13.5	4.89	36.9	1	11
Do	do	3	11.0	5.04	45.7	2	6
Do	do	4	11.3	5.46	48.34	3	2
F. E. Davis, Dublin, Erath County, Tex.	Central North ▯	† 1	12.55	7.07	56.04	2	11
		1	16.5	9.69	58.7	1	7
C. W. Griffin, Toyahvale, Reeves County, Tex.	Pecos Region ▭	†1	15.0	9.5	63.3	1	6
Do	do	2	21.1	15.08	71.5	1	8½

* 4 beets, 1 sample. † Red.

TENNESSEE.

Seventeen samples of beets were received at the laboratory of the Department of Agriculture from Tennessee, of which eight were from the agricultural experiment station at Knoxville. The mean weight of the beets received was 11 ounces, the mean percentage of sugar 10.8, and the mean purity 71.9. The mountainous regions of Tennessee are probably favorably situated in regard to thermal conditions for the

growing of beets, but the contour of the country will prevent any extensive planting of this crop. Middle and western Tennessee are evidently too warm for successful beet culture.

Virginia.

Thirty-four samples grown in the State of Virginia were received at the Department of Agriculture for examination. The mean weight of the beets composing these samples was 21 ounces, the mean content of sugar in the beets 11.6 per cent, and the mean purity 76.2.

Virginia lies almost entirely south of the region where thermal conditions are most favorable to beet culture. It is only in the seacoast counties, where the temperature is moderated by the sea breezes, and in the mountainous counties, where the altitude is great enough to lower the temperature, that good results can be expected. A great deal of interest has been manifested in the State in regard to the building of factories, but it is evident that intending investors as well as farmers should stop to consider the matter very seriously before investing their money and their labor in this enterprise.

A few analyses received from Virginia show favorable results, as for instance, the sample from Carroll County, weighing 15 ounces, and containing 15.4 per cent of sugar in the beet. There is little in the data, however, to encourage the belief that Virginia is a favorable region for beet growing.

Investigations were also made by the agricultural experiment station of Virginia, but only to a very limited extent. The data obtained on analysis, together with the observations of the official in charge of the investigations, are found in the following report:

Investigations by the agricultural experiment station of Virginia.

Before stating the results of the analyses made at this station I think it best to make some comments upon the work attempted this season. In the first place, it was quite late before we concluded to undertake the distribution of seeds and then by the time they reached us from the Department of Agriculture the season was so far advanced that a considerable number of persons to whom the seeds were distributed failed to plant them. This, of course, disturbed the experiment to a considerable extent. Another disturbing factor was the extreme drought which prevailed during the latter part of the season over this State in general, which resulted in many cases in practically destroying the crop. As a consequence, our results are not what we could wish. After much correspondence with those to whom seed was distributed, we concluded to analyze only samples representing fairly well the tide-water and limestone sections of the State. The results of these analyses follow:

Sample No. 1. From W. J. Phillips, Accomac County, Va. Weight of whole beet, 372 grams. Per cent of sugar, 16.11.

Sample No. 2. From Henry Jones, Suffolk, Nansemond County, Va. Weight of whole beet, 1,325 grams. Per cent of sugar, 4.17.

Sample No. 3. From L. T. Barnes, Boulevard, New Kent County, Va. Weight of whole beet, 581 grams. Per cent of sugar, 14.64.

Sample No. 4. From T. A. Eller, Atkins, Smyth County, Va. Weight of whole beet, 760 grams. Per cent of sugar, 9.61.

Sample No. 5. From experiment station. Weight of whole beet, 584 grams. Per cent of sugar, 13.63.

The first three samples represent the eastern section of the State and the last two the limestone section. We endeavored to secure sixteen samples covering more perfectly the geologic areas of the State, but from the causes above mentioned we failed to procure proper samples.

Dr. McBryde desires me to say that if the Department wishes us to aid in the conduct of this work the coming year we will be pleased to do so, and that the work will be taken in hand in proper season and the growing experiments arranged on a much better plan, so as to secure reliable samples from the different sections of the State.

Experiments in the growth of beets in Virginia during 1897 were also made by the State board of agriculture, and are described on page 206 of the annual report of the board for the year 1897. One hundred and eight samples were analyzed during September and October. It is stated in this report that these samples varied in saccharine strength from 8.5 to 17.1 per cent; thirty-five of them were below 12 per cent, and seventy-three showed a saccharine value of from 12 to 17.1 per cent, with a coefficient of purity of from 79 to 88.5, or a saccharine average of 14.7 per cent, and an average purity coefficient of 85, which is equivalent to 250 pounds of raw sugar per ton of beets.

The data obtained by the State board of agriculture are more favorable than those secured by the Department of Agriculture or by the experiment station at Blacksburg. It is hardly probable, however, that the map which accompanies the report of the State board of agriculture will be regarded as a final judgment in regard to the localities in Virginia suitable to the growth of beets of the different qualities noted. A much larger series of experiments, extending over a greater number of years, will be necessary to definitely determine that point.

Washington.

Thirty-four samples of beets grown in the State of Washington were received at the Department of Agriculture for analysis. The mean weight of the beets received was 27 ounces, the mean percentage of sugar 13.7, and the mean purity coefficient 80.7.

The agricultural experiment station of the State of Washington for many years has conducted careful studies in regard to the possibilities of producing sugar in that State. During the past year 60 samples of beets grown in Washington were analyzed at the laboratory of the agricultural experiment station. The mean weight of the beets analyzed was 23 ounces, the mean percentage of sugar in the beets 13.6, and the mean coefficient of purity 75.7. Of the whole number 68 per cent contained over 12 per cent of sugar, and 78 per cent weighed more than 16 ounces. The reports of the director and chemist of the station are given below.

Summary of analyses of beets from Washington.

[Compiled from report of experiment station.]

County.	Number of samples.	Net weight beets.	Sugar in beets.	Coefficient of purity.	County.	Number of samples.	Net weight beets.	Sugar in beets.	Coefficient of purity.
		Ounces.	*Per ct.*				*Ounces.*	*Per ct.*	
Clarke	1	29	14.3	77.7	King	10	15	12.1	71.4
Pierce	7	25	12.0	73.7	Clallam	1	54	14.3	77.4
Lincoln	20	17	15.8	79.2	Whitman	2	46	14.2	76.3
Kitsap	2	22	12.3	70.9	Klickitat	2	26	12.4	74.5
Skagit	8	33	12.5	72.9					
San Juan	4	27	13.5	75.6	Averages, etc.	60	23	13.6	75.7
Whatcom	3	25	11.8	80.4					

RESULTS OF EXPERIMENTS IN WASHINGTON.

I have the honor to report as follows:

The appointment was made so late in the summer that it served only the purpose of providing for the free transportation of beets to this point for analysis, consequently the report must necessarily deal with facts of an earlier date chiefly, if it is to be of any value as an indication of the adaptability of the soil and climate of the State of Washington to the culture of sugar beets. Permit me to say that we regarded our experimentation as practically complete before the beginning of this year. In consequence of this fact it had been announced early in the season that no distribution of seed would be made. At a later period some seed was obtained from the Department of Agriculture. The planting season in Washington begins very early considering the latitude, and the seed was received too late for general use. Seed was, however, supplied to those requesting it, and in the main these requests were from localities not so well adapted to the culture of sugar beets, so that the results of this year's planting can in no way be taken as representative.

The Washington State Experiment Station began the investigation of this problem through its chemical department in the spring of 1894, and conducted it with the greatest thoroughness through that and the two succeeding seasons, making more than 3,000 analyses. Beets were raised in both small and large plats. The results were so uniform as to demonstrate the peculiar adaptability of this region to the culture of sugar beets. These results are given in Bulletins 15 and 26 of the State experiment station. I submit herewith the report of Professor Fulmer, of the department of chemistry, relative to the results of this year. I might mention the fact that Professor Fulmer was for some time chemist of a beet-sugar factory in Nebraska, and is particularly well fitted for dealing with this subject. The results thus far obtained in the State show a percentage of sugar of about 15, and a purity of nearly 84.

PULLMAN, WASH., *January 6, 1898.*

DEAR SIR: In compliance with your request I hand you herewith a tabulated statement of the analyses made in the station laboratory of beets grown from seed furnished by the United States Department of Agriculture. The data presented are far from being complete. The very important item of "variety of seed" is entirely omitted, because in almost all cases the variety indicated by the grower of the beets was not at all in harmony with the characteristics exhibited by the samples. For example, beets with pink skins were often marked "Kleinwanzlebener," which is a pure white variety. It is quite clear to my mind that the lack of harmony between the character of the beets and the names they bore was due to the seed sent out by the Government being a mixed seed.

Parties sending in beets for analysis failed in most cases to send any data concerning the time of planting, thinning, and harvesting; character of soil; amount of cultivation, etc. On account of this great lack of reliable data, the meager results obtained are of little value.

I wish to direct your attention to the fact that this kind of experimental work with sugar beets in our State is at this time a useless expenditure of time and energy. During the past four years this station has made over 3,000 analyses of sugar beets grown in all parts of the State, and under all conditions of temperature and rainfall. The details of these analyses, and of the field experiments, have been published in full in Bulletins 15 and 26. The raising of high-grade beets in this State has been fully demonstrated to be a practical success, and we believe any further experimentation with small plats is wholly unnecessary.

The uniformly excellent results that we have obtained in the past are in striking contrast to the very poor outcome of this year's test. We believe the low sugar content and purity exhibited by the beets this year is due to several causes:

(1) The seed from Washington was received altogether too late in the spring for distribution in time for early planting. In most sections of the State the seed should be planted not later than the middle of April.

(2) Nearly all of the samples were grown in sections of the State that have not heretofore shown any special adaptability to sugar-beet culture.

(3) We believe the seed was of poor quality. In support of this assertion I wish to call your attention to the samples that were raised at Crescent, in Lincoln County. Heretofore this section has always produced high-grade beets. The samples sent in by William Adam, P. Carstens, and the first two of W. B. Warren were grown from Government seed, and gave a very low sugar content and purity. The samples of Wollweber, and the last three of Warren, were grown from seed raised at Crescent last year, and gave most excellent results. These facts and the very general poor quality of samples leads me to regard the seed furnished as an inferior quality.

The inclosed results do not do justice to our State, and I wish to protest against their publication as an index of the character of beets that can be raised here.

Yours, very respectfully,

ELTON FULMER,
Chemist Experiment Station.

Director E. A. BRYAN,
Pullman, Wash.

In regard to the report of the chemist, attention should be called to the fact that he is evidently mistaken in regard to the quality of the seed sent by the Department of Agriculture. This seed was, of course, not of the direct production from high-grade mother beets, but was the ordinary commercial seed which was imported by the Oxnard Company for distribution among their beet growers. It was the same seed which was sent to Michigan and to New York, which produced in those States the excellent results which have been recorded in previous portions of this report. In over 2,200 analyses of beets which were made in this laboratory during the past season, only about 25 samples were received which had a pink skin, and in most cases these were marked with different names. It is possible, however, that a few seeds of this kind may have been mixed in with the large lot of commercial seeds which were imported into this country. The Department of Agriculture neither purchased nor packed the seeds which were dis-

tributed, so that the possible admixture of other varieties can not be positively denied.

With the exception of the excessive rainfall on some of the coast areas, it has been demonstrated that the State of Washington is well suited to the growth of beets of a high grade. An extended report on the possibilities of Oregon and Washington for beet production was made in Bulletin No. 5 of this Division, the investigations, which were published in 1885, having been made in the autumn of 1884. A description of the topographical features and climate of western Washington is given on pages 103–104 of that bulletin. The conclusions which I derived from a study of the conditions at the time are given on page 105 in the following words:

"In view of the preceding description I am inclined to believe that in Washington Territory and Oregon, soil and climate are very favorable to the growth of a sugar beet of high saccharine strength.

"The mildness of the winter is, though to a less degree than in California, favorable to the season of manufacture. With a wise and careful encouragement of the industry I have no hesitation in saying that the prospects for the development of an indigenous sugar industry in the extreme northwestern part of our country are decidedly bright. It is a field worthy the attention both of experimenters and capitalists."

Investigations which have been made subsequent to this period have abundantly verified the predictions given above. The chemist of the station, in the results of his work for 1897, says that the data are not so favorable as were obtained in preceding investigations, but, as he says, the beets analyzed came from parts of the State less favorable to beet culture than did those samples which had previously been examined. The data obtained by analyses of beets received at the Department from Oregon are decidedly favorable. The average size of the beets, 27 ounces, shows the possibilities of a large yield, while both the content of sugar and the purity coefficient are favorable to the production of large quantities of sugar from the beets produced. The thermal conditions which prevail in Washington are noticed in another place. The coast region is cooler than the mean temperature of 69° for the summer months, but, as has been remarked before in more than one place, this is not unfavorable to the production of high-grade beets; on the contrary, rather promotive of it. The mild autumns, especially in the western part of the State, afford ample opportunity for the complete harvest and care of the beets. In considering the data which have been obtained through a long series of years, therefore, it is safe to say that there are extensive areas in the State of Washington which invite the careful consideration of intending investors in the beet-sugar industry.

Wisconsin.

Forty-two samples of beets were received at the laboratory of the Department from Wisconsin, of which number 31 were grown in Dane County, representing the beets grown by the agricultural experiment station. It is evident, that the mean results of the samples from Wisconsin are influenced in a marked degree by those obtained from the agricultural experiment station. These mean results therefore represent a higher quality of beets than would have been grown in the promiscuous manner already referred to. The mean weight of the beets grown in Wisconsin was 15 ounces, the mean content of sugar therein was 15.8 per cent, and the mean purity 83.3. The small mean size of the beets is due chiefly to the 31 samples received from the agricultural experiment station, of which the average weight was only 11 ounces. With the exception of 1 sample from Outagamie County, which weighed only 8 ounces, the other samples were of good size. Especially is this true of the 3 samples received from Racine County, the mean weight of which was 34 ounces, the mean content of sugar 15.4 per cent, and the mean purity 82.6.

The data obtained by our analyses are encouraging, but, on account of the small number of samples, not convincing. Therefore the following report of the results of the analyses made at the agricultural experiment station will show more conclusively the influence of the character of the soil and climate of Wisconsin on the quality of sugar beets.

Experiments conducted by the agricultural experiment station of Wisconsin.

Three classes of experiments were conducted by the agricultural experiment station of Wisconsin during the year 1897. An elaborate report of these experiments has already been printed as Bulletin No. 64 of that station. The following interesting summaries represent the principal data obtained:

The three methods were the following:

First method.—A general distribution of seed was made promiscuously to farmers in the State who desired to experiment. In all, 13,766 packages were distributed. Each package contained directions for planting and cultivating the beet. One thousand six hundred and sixty-three samples of beets grown under these auspices were received at the station for analysis. The quality of the beets, together with the analyses of beets grown in 1890, 1891, 1892, and 1897, with a summary for the four years, is shown in the table on page 120.

Results of analyses of sugar beets grown on Wisconsin farms during 1890–1892 and 1897.—Averages by counties.

County.	1890–1892.				1897.				Summary for four years.			
	Number of samples.	Sugar in juice.	Purity coefficient.	Estimated yield per acre.	Number of Samples.	Sugar in juice.	Purity coefficient.	Estimated yield per acre.	Number of samples.	Sugar in juice.	Purity coefficient.	Estimated yield per acre.
		P. ct.	*P. ct.*	*Tons.*		*P. ct.*	*P. ct.*	*Tons.*		*P. ct.*		*Tons.*
Adams	3	11.99	76.1	9.3	6	13.67	75.5	10.2	9	13.11	75.9	9.8
Ashland	.....	.....	.....	.....	5	11.42	74.2	3.0	5	11.42	74.2	3.0
Barron	3	12.74	77.0	17.7	15	12.94	74.3	12.0	18	12.90	74.7	14.1
Bayfield	.....	.....	.....	.....	1	10.96	73.5	16.5	1	10.96	73.5	16.5
Brown	4	10.75	74.9	17.9	101	13.12	75.5	14.0	105	13.03	75.5	14.3
Buffalo	9	13.48	77.4	15.9	8	12.96	75.3	11.2	17	13.24	76.4	13.0
Burnett	.....	.....	.....	.....	2	12.92	75.0	18.0	2	12.92	75.0	18.0
Calumet	8	16.67	82.6	14.7	48	12.61	72.4	11.8	56	13.19	73.8	12.1
Chippewa	13	12.72	77.5	23.6	34	12.18	74.2	11.7	47	12.25	75.2	15.1
Clark	7	14.15	81.4	10.9	61	11.97	74.9	11.7	68	12.19	75.6	11.6
Columbia	19	12.28	74.7	15.5	30	12.68	71.8	13.4	49	12.53	72.9	14.2
Crawford	4	10.09	72.0	15.3	2	12.09	72.3	9.7	6	10.76	72.1	13.1
Dane	14	12.98	76.7	14.4	44	13.51	71.3	12.7	58	13.37	72.6	13.2
Dodge	13	11.77	76.2	20.7	47	12.86	71.9	12.5	60	12.62	73.0	13.8
Door	3	14.59	80.0	21.4	15	15.11	77.4	10.0	18	15.02	77.7	13.0
Douglas	.....	.....	.....	.....	8	13.92	78.8	16.7	8	13.92	78.8	16.7
Dunn	13	12.49	79.8	11.5	26	12.97	73.7	12.6	39	12.86	75.6	12.2
Eau Claire	10	11.70	76.0	14.0	63	10.70	73.8	11.0	73	10.84	74.1	11.5
Fond du Lac	10	12.13	74.1	11.0	38	12.04	71.2	16.6	48	12.07	71.7	15.1
Forest	1	9.64	72.5	6.0	1	11.31	70.2	15.0	2	10.47	71.3	10.5
Grant	9	10.24	69.3	13.2	26	12.21	71.2	13.0	35	11.74	70.5	13.0
Green	6	12.84	77.5	15.2	4	10.16	65.5	14.0	10	11.77	72.7	15.0
Green Lake	1	11.31	78.1	.....	13	12.06	72.9	11.5	14	12.01	73.2	11.5
Iowa	7	11.32	74.9	27.8	1	10.40	70.2	12.0	8	11.20	74.3	22.5
Iron	.....	.....	.....	.....	1	9.96	64.7	15.5	1	9.96	64.7	15.5
Jackson	1	7.79	65.6	.....	64	11.57	77.4	10.6	65	11.51	77.2	10.6
Jefferson	23	13.96	79.0	17.5	13	13.55	72.8	15.0	36	13.81	76.8	16.5
Juneau	6	13.04	76.0	25.3	9	12.34	72.9	6.2	15	12.63	74.1	13.2
Kenosha	1	12.71	78.1	21.8	13	14.31	74.2	15.0	14	14.19	74.5	15.7
Kewaunee	30	13.58	77.1	35.1	74	13.38	75.4	14.2	104	13.44	75.8	16.8
La Crosse	10	12.58	76.1	15.2	60	12.75	80.6	12.5	70	12.72	79.9	13.0
Lafayette	4	12.27	77.0	26.4	6	10.47	66.3	9.4	10	11.19	70.6	16.0
Langlade	1	12.91	81.4	24.1	15	11.51	70.8	11.0	16	11.59	72.1	12.0
Lincoln	3	17.43	85.9	13.1	7	13.09	75.9	4.5	10	14.39	78.9	10.9
Manitowoc	16	12.61	80.4	16.4	49	13.42	74.9	14.4	65	13.22	76.3	14.8
Marathon	9	12.67	76.5	16.1	44	11.99	72.3	12.4	53	12.10	73.0	12.9
Marinette	2	8.77	64.5	28.5	27	13.23	76.6	9.5	29	12.92	75.7	10.9
Marquette	.....	.....	.....	.....	15	13.19	77.7	8.0	15	13.19	77.7	8.0
Milwaukee	6	15.51	83.4	19.8	14	14.17	77.7	15.2	20	14.57	79.4	18.4
Monroe	16	12.32	76.2	12.3	24	12.36	73.1	11.4	40	12.34	74.3	11.8
Oconto	12	13.76	80.7	13.5	11	15.48	79.6	17.4	23	14.56	80.2	15.1
Oneida	.....	.....	.....	.....	4	13.78	75.5	.....	4	13.78	75.5	.....
Outagamie	14	11.48	75.2	23.6	63	13.06	75.4	15.0	77	12.77	75.3	16.6
Ozaukee	5	13.14	79.0	20.7	17	14.00	75.7	11.1	22	13.81	76.5	13.0
Pepin	5	14.71	79.1	11.9	4	11.82	73.7	23.5	9	13.43	76.6	17.7
Pierce	.....	.....	.....	.....	12	12.56	73.2	15.0	12	12.56	73.2	15.0
Polk	1	11.09	75.4	.....	5	11.90	72.6	17.3	6	11.76	73.0	17.3
Portage	8	12.02	75.1	12.5	33	13.12	73.2	8.3	41	12.91	73.6	9.3
Price	.....	.....	.....	.....	7	10.43	67.2	11.0	7	10.43	67.2	11.0
Racine	4	14.27	80.6	10.5	17	13.75	75.3	14.3	21	13.85	76.3	13.9
Richland	9	11.34	79.6	12.9	15	10.61	68.7	15.3	24	10.88	72.8	14.4
Rock	17	12.96	76.7	11.4	36	13.97	73.5	15.1	53	13.64	74.5	14.0
St. Croix	8	12.55	74.7	19.9	18	12.11	72.2	13.3	26	12.24	73.0	15.3
Sauk	8	9.67	71.5	23.8	23	12.78	72.4	13.0	31	11.98	72.2	14.8
Sawyer	1	10.69	73.8	26.1	.....	.....	.....	.....	1	10.69	73.8	26.1
Shawano	7	12.53	76.3	16.9	28	13.35	75.0	8.2	35	13.19	75.3	10.4
Sheboygan	27	11.71	74.3	16.8	55	12.96	78.0	15.1	82	12.55	76.8	15.6
Taylor	15	13.61	78.9	8.8	10	10.87	70.6	13.6	25	12.52	75.5	11.0

It will be noticed that the table includes the analyses of 527 samples collected during the years 1890–91–92, together with the 1,663 collected in 1897, or a total of 2,190 samples. In the discussion of the analytical data Mr. F. W. Woll, who has compiled the report, makes the following interesting observations:

Sixty-eight of the counties of the State are represented in the sugar-beet analyses made during the past season. Brown county leads with 101 samples of beets,

Kewaunee being second with 74 samples. Ten counties furnished 50 or more samples each. The highest average for the sugar in the juice, 11 samples analyzed, was obtained for Oconto County, namely, 15.48 per cent with a purity coefficient of 79.6, followed by Door County, which gave 15.11 per cent sugar in the juice, purity 77.4, as the average of 15 samples. The average sugar content of the juice of the beets was above 12 per cent in case of 49 counties, above 13 per cent in case of 26 counties, and above 14 per cent in case of 8 counties.

Adaptability of different parts of the State to sugar-beet culture.—A close study of the results given in the preceding tables will be of interest, and is necessary in order to properly understand the situation of the question of sugar-beet culture in our State. The table indicates what an investigation continued through four growing seasons has revealed as to the adaptability of the soil in different parts of the State to the culture of this crop. In case of a few counties, especially the extreme northern ones, the number of analyses made is not sufficiently large to warrant our drawing definite conclusions as to the quality of beets there grown, but in the large majority of counties the number of analyses is ample to be considered a true representation of what beets grown in the respective counties will show when raised by farmers who have no special knowledge of the requirements of the sugar beet as to culture, soil, etc.

If the averages of the sugar contents for the various counties, as given in the last table, be marked on a Wisconsin map, and the counties whose averages come, say, above 13 and above 14 per cent of sugar in the juice be shaded, it will at once be noticed that the counties producing the richest beets are those lying east and southeast of the Wisconsin River, and those in the northwestern corner of the State along the Mississippi and St. Croix rivers, from Buffalo County and north. The Lake Shore region is shown to be peculiarly well adapted to the culture of sugar beets; all counties producing beets with an average content of sugar in the juice above 14 per cent in the past season's analyses border on Lake Michigan or are adjacent to counties bordering on this lake.

Mr. Woll is also of the opinion that those soils of the State which have been derived from limestone are best suited to the growth of sugar beets. He makes the following comment in regard to the sugar content of the beets:

Sugar content of beets.—The table shows that the average per cents of sugar in the juice for the years given were as follows: 1890–1892, 12.76 per cent; 1897, 12.67 per cent, or an average of 12.70 per cent for the years 1890–1897, the last figure being the mean of nearly 2,200 analyses. The usual minimum standard for beets adapted to factory purposes is 12 per cent sugar in the beet. Since beets contain about 95 per cent of juice, this will correspond to $\frac{12}{95} = 12.63$ per cent of sugar in the juice. Our average therefore exceeds this minimum figure by a small fraction of 1 per cent.

The influence of the character of the soil upon the weight, sugar content, and purity of the beets is summarized by Mr. Woll in the following statements:

In the sections of our State where exclusive grain raising has given way to diversified farming, dairying, stock raising, or market gardening, the land is usually in a good state of fertility, and a sufficient amount of barnyard manure is produced every year so that no artificial fertilizers need be purchased. But where grain raising is still continued as the sole reliance of the farmers, there is no hope for sugar-beet culture until the system of farming is changed, and the manure produced by the stock kept is carefully saved and applied, or commercial fertilizers are purchased for the beet fields.

Second method.—The second line of investigations conducted by the experiment station consisted in the establishment of substations in different parts of the State. As was mentioned in a previous part of this report, this is by far the most hopeful manner of conducting an agricultural survey of the State for the purpose of determining its suitability for the growth of sugar beets. In all, 33 farmers who took charge of this substation work made complete reports to the central station. The average expense per acre reported by 32 of these was $28.73. One report, showing an expense of $94.34 per acre, was excluded from the average. The average yield per acre, as reported from the 33 stations, was 29,850 pounds, or 14.9 tons of 2,000 pounds each per acre. This yield includes only 27 returns, since 6 of the substations failed to return the yield per acre. The lowest yield per acre reported was 6 tons, and the highest 24.8 tons. The average result of the analyses of the samples from the different substations is shown in the following table:

	Weight of beets.	Sugar in juice.	Purity coefficient.	Weight of beets.	Sugar in juice.	Purity coefficient.
	Pounds.	*Per cent.*	*Per cent.*	*Pounds.*	*Per cent.*	*Per cent.*
Average for 23 substations in southern half of State (30 and 31 samples, respectively)	1.17	13.58	80.0	1.79	15.35	79.0
Average for 13 substations in northern half of State (17 and 15 samples, respectively)	1.42	13.35	81.7	1.59	14.97	82.5
Average for 36 substations (47 and 46 samples, respectively)	1.26	13.49	80.6	1.72	15.22	80.2

For the first attempt at collecting data by a complete agricultural survey, the above results may be regarded as exceedingly encouraging. With larger experience on the part of the farmers in charge of the experiments, however, much more valuable and convincing data might be obtained.

Third method.—The third class of experiments conducted by the Wisconsin station consisted in investigations at the station farm itself. For the details of these experiments Bulletin 64 may be consulted. The following is a summary:

The field selected for the experiments was divided into two portions. The eastern half had been a meadow continuously since it came into cultivation up to 1895, when rape was grown thereon, followed by a crop of peas in 1896. The western half of the field had been plowed only once during the past twenty years, when it was cultivated in Indian corn. It had been pastured during the past ten years until 1896, when it was planted to rape and the rape eaten off by sheep. The beet crop did not do well on this field, the whole northwestern portion of it, after the 1st of August, showing no increase in the growth of the beets, the foliage turning yellow and the plants dying away to a large extent. The field was plowed 6 inches deep on May 7, and plowed again 12 inches deep on May 20. About four-fifths of it

was subsoiled to a depth of 6 inches. The agricultural analytical data obtained from this field are given in the following table:

Yield of beets and of sugar per acre, main field.

No. of plat.	Name of seed.	Eastern half.				Western half.			
		Yield of beets from plat.	Yield of beets per acre.	Sugar in the beet.	Sugar per acre.	Yield of beets from plat.	Yield of beets per acre.	Sugar in the beet.	Sugar per acre.
		Pounds.	*Pounds.*	*Per ct.*	*Pounds.*	*Pounds.*	*Pounds.*	*Per ct.*	*Pounds.*
1	Kleinwanzlebener, Neb	3,422	24,010	12.72	3,059	2,874	25,030	15.80	3,959
2	Desprez, Men	2,826	22,060	11.71	2,543	3,122	30,230	13.71	4,144
3	Kleinwanzlebener, Agnew	3,053	21,450	10.96	2,352	2,301	32,120	15.17	4,873
4	Kleinwanzlebener, Hoerning	2,875	20,160	15.04	3,038	1,299	20,210	17.06	3,448
5	Vilmorin Improved	2,221	15,610	14.68	2,291	1,308	15,030	14.28	2,141
6	Vilmorin Kleinwanzlebener	2,473	17,380	10.65	1,850	2,728	23,770	14.98	3,561
7	Vilmorin French	2,485	17,460	11.26	1,966	2,701	23,540	13.58	3,196
8	Kleinwanzlebener, Floto*	2,258	15,860	14.24	2,259	1,472	12,820	14.05	1,801
9	Desprez White, No. 2*	2,081	14,620	10.95	1,602	1,429	12,460	14.38	1,790
10	Desprez White, No. 2 B*	2,108	14,810	15.05	2,228	1,408	12,270	11.71	1,436
11	Wernich's Kleinw., Floto*	2,111	14,840	15.65	2,320	1,236	10,760	13.62	1,467
12	Demesmay*	1,321	15,510	14.23	2,207	799	11,600	10.28	1,192
13	Kleinwanzlebener, Neb. (2)*	887	20,760	15.83	3,287	355	10,300	10.75	1,058
	Averages, etc	30,121	18,043	13.22	2,385	23,032	18,472	14.18	2,620

* Not included in average for western half.

The cost of cultivating this field is given as follows:

Cost of growing an acre of sugar beets.—A careful account was kept throughout the season of the labor done on the 3-acre beet field; valuing labor as previously given, we have the following summary:

Plowing and preparing the land	$12.42
Planting	1.70
Cultivating, hoeing, thinning and transplanting	51.63
Harvesting and placing in cellar	31.60
Total	97.35

This sum, $97.35, or $32.45 per acre, does not include the cost of seed or rent of land. It is nearly $4 higher than the corresponding figure obtained as the average for 28 substations; the greater cost with us is easily accounted for by the weedy condition of the western half of the field, as well as by the fact that the harvesting of our beets was a comparatively slow and difficult job, since the different lots and varieties had to be harvested and kept separately.

In addition to the work summarized above the station took part in the growth of high-grade beets on special plats under the supervision of the Department. The results of these experiments are given in another place.

WYOMING.

Thirty-four samples of beets grown in Wyoming were received at the Department of Agriculture for analysis. The mean weight of the beets received was 19 ounces, the mean content of sugar in the beet 17.2 per cent, and the mean purity 82.3. These data are exceptionally fine, and show that, in so far as the production of a crop is concerned, Wyoming will be able to compete with any State in the Union. The thermal conditions which prevail in the State are extremely irregular, the low valleys having warm and the high plateaus cool summers. It

is evident that only on the plateaus, where the land is reasonably level, and where irrigation can be practiced, will it be possible to grow, with absolute certainty, a crop of beets of high saccharine strength.

Among the counties of Wyoming the two which furnish the most data are Converse and Big Horn. Converse County lies in the southeastern part of the State and Big Horn in the northwestern. In the beets from Converse County the average weight was 26 ounces, the mean content of sugar 17.8 per cent, and the mean coefficient of purity, 82.2. Big Horn County furnished six samples, of which the average weight was 20 ounces, the mean content of sugar 18.7 per cent, and the mean coefficient of purity 82.2.

When these analyses were made, showing such fine results, we wrote at once to the parties to see if we could not get a quantity of the beets for mothers in producing beet seed. The reply was made that they had all been frozen, and therefore no samples could be furnished. This reply to our inquiry indicates the chief difficulty to be encountered in Wyoming in introducing the beet industry, namely, the sudden advent of cold weather and the severity of the early winters in that locality. In Big Horn County some of the altitudes are 10,000 feet, and the whole county has a very great elevation. In the southeastern portion of the State the altitude generally reaches 7,000 feet. It is evident, therefore, that these high elevations give cool summers and favor the early advent of winter.

Another point to be considered is the mountainous character of the State, which, of course, precludes the possibility of culture over extensive areas. In low valleys protected by mountain ranges, if from 15,000 to 25,000 acres of land in a body could be secured, it seems probable that the industry of beet growing might be introduced with every probability of success. The temperature conditions, however, of October and November should be most carefully considered, as it would doubtless be necessary, even in the most favored valleys of Wyoming, to have the beets securely protected by the middle or end of November. This short harvesting season can not help but add a great deal to the cost of production, and hence must be taken into consideration.

In that part of the country also the question of the supply of water is a very important factor, and must not be lost sight of, as not only will water be required for the growing of crops, but also in immense quantities for manufacture.

The data at hand only permit us to study the composition of the beet itself, and surely Wyoming is to be congratulated on having produced, judged from the limited number of samples supplied, an excellent quality of beets.

VERMONT.

Only 8 samples of beets from Vermont were received at the Department of Agriculture, and these were of very high quality. The mean weight of the samples received was 22 ounces, the mean content of sugar in the beet 14.2 per cent, and the mean coefficient of purity, 84.1.

At the agricultural experiment station of Vermont 32 samples were received. The average weight of the beets received at the experiment station was 17 ounces, the mean percentage of sugar in the beet 16.3, and the mean purity 84.2. In reporting the results of the experiments the director of the station makes the following observations:

RESULTS OF EXPERIMENTS IN VERMONT.

One hundred persons guaranteed at the outset of the season to grow the crop and ship us samples. We had returns from twenty-seven. The remaining seventy-three, however, were not so much at fault as was the Weather Bureau. The weather throughout the State during the months of May, June, and July and the first part of August was execrable, there being several times the normal rainfall. In almost every case of not sending samples the report was that the crop was drowned out. It strikes me as somewhat doubtful whether the results obtained in the twenty-seven cases reported are truly representative of what might be expected under normal conditions of weather. The percentages of sugar certainly run quite high. I find that several of the growers sent their samples to Washington. I should be gratified, if it were possible, to receive the statement of the analyses, as we may wish to make some use of the sugar-beet data ourselves, which, as I understand, we are at liberty to do.

The majority of those who made a failure of the work this year expressed their desire to try again next year.

Of 32 beets analyzed at the agricultural experiment station of Vermont the number containing from 12 to 14 per cent of sugar was 2; the number containing from 12 to 14 per cent of sugar and weighing 16 ounces or over was 1; the number containing more than 14 per cent of sugar was 28; the number containing more than 14 per cent of sugar and weighing 16 ounces or more was 12.

It is seen from the above data that the only limitations upon the growing of beets in Vermont are the extent of the area suitable to the culture of the beets and the length of the growing season. It is evident, in so far as growth is concerned, that such a season as that of 1897 is capable of producing beets of the highest grade, but the growing season includes properly the season of harvest and preservation of the beets. The high northern latitude of Vermont and the early and severe winters must be taken into consideration in this particular. Vermont is also a mountainous country, and the areas of level land are not proportionately so great as in most of the States which have been considered for beet growing. Where bodies of from 15,000 to 25,000 acres of level and fertile land can be found with the autumnal conditions favorable for the harvest and preservation of the beets, there is no reason to doubt the possibility of successfully establishing the beet-sugar industry.

INFLUENCE OF TEMPERATURE ON THE QUALITY OF SUGAR BEETS.

The influence of temperature and other climatic conditions upon the growth of beets is discussed under the head of special experiments in growing beets from high-grade seeds. It will be interesting, however, to compare the deductions from that discussion with those from data

obtained from certain parts of the country where favorable conditions exist for making this comparison. The States of Ohio, Indiana, and Illinois are situated in a peculiarly favorable manner for a study of this kind. Each of these States has a portion of its area in the theoretical thermal belt and a large portion of its area outside of that belt. In each of these States, therefore, the data received from the various counties were classified into three portions, namely, the northern, the central, and the southern belts.

The following is a tabulation of the data from each one of these sections in the three States:

Relation of latitude to development of sugar content.

	Northern belt.			Central belt.			Southern belt.		
	Average weight of beets.	Sugar in beets.	Purity coefficient.	Average weight of beets.	Sugar in beets.	Purity coefficient.	Average weight of beets.	Sugar in beets.	Purity coefficient.
	Ounces.	*Per ct.*		*Ounces.*	*Per ct.*		*Ounces.*	*Per ct.*	
Ohio	29.4	13.6	79.4	32.6	13.2	78.0	35.0	12.2	75.3
Indiana	18.9	13.3	81.9	18.5	12.9	80.7	14.2	10.7	78.0
Illinois	22.0	13.2	79.3	20.0	11.5	75.4	19.0	11.1	74.7

The data in the above table have a peculiar value in establishing, by experimental results, the validity of the scheme employed in the construction of the theoretical thermal belt suitable to the growing of beets. In every one of the States mentioned there is a gradual deterioration in the quality of the beet, both as respects its sugar content and its purity, in passing from the northern to the southern belt of the State. It may be said that the difference between the two extreme areas is not very great, and that for this reason it would be advisable to establish factories indiscriminately in one or the other of the belts, according to more or less favorable local conditions, aside from the sugar content of the beet. The fallacy of this statement, however, will be evident to anyone who studies carefully the conditions of manufacture. An increase of 1 per cent in the sugar content of the beet means an increase of 20 pounds per ton in the amount of sugar manufactured, without any corresponding increase in the expense of manufacture. In other words, the cost of extracting the sugar from a ton of beets which would yield 180 pounds would be just as great as that attending a ton of beets which would yield 200 pounds of sugar. But the additional value of the 20 pounds of sugar manufactured might in many instances determine whether the business would be conducted at a profit or a loss. The above assumption is true on the supposition that the coefficient of purity remains the same in each case. When we consider in addition to the loss of the sugar, the depreciation in the purity of the juice, the discrepancy between the sections becomes all the greater. Not only is the loss attending the lower sugar content of the beet to be considered, but also the additional loss

which is coupled with the lower purity. In other words, a ton of beets with a coefficient of purity of 80, which would yield 200 pounds of sugar by the ordinary processes of manufacture, would yield very much less than this if the purity coefficient should fall to 76, and would yield very much more if it should rise to 85. The data obtained in the above table afford convincing proof of the fact that it is not safe to push the manufacture of beet sugar too far south of the theoretical thermal belt, unless the depreciation in the sugar content and purity of the beet is compensated for by some remarkable local factors, in the way of cheapness of manufacture, which will make good the loss due to the low content of sugar and the low purity of the juice. These figures, obtained in this miscellaneous way, are fully corroborated by the careful experimental data obtained in the culture of high-grade beets at the six stations which are mentioned in another place. From exactly the same seeds, planted in exactly the same way and cultivated in the same manner, exceptionally high-grade beets of fine sugar content and high purity were obtained from the New York station, good beets were grown at the Wisconsin station, fairly good beets at the Iowa station, beets with a fairly good content of sugar but diminutive in size on account of the drought at the Indiana station, beets of good size and very low content of sugar at the Kentucky station, beets of only minimum content of sugar and very small size at the Tennessee station. These results are such as should be studied carefully by intending investors who desire to place their money where the certainty of return is the greatest. With such magnificent areas open to cultivation as are found in the States of New York, northwestern Pennsylvania, northern Ohio, northern Indiana, and southern Michigan, it would not be wise for men of capital to select localities which the figures at hand indicate are less favorable to the production of high-grade beets. The data which have been obtained from New York and from Michigan indicate that with the best principles of culture, with good fertilization and skilled oversight, beets can be grown over wide areas fully equal in sugar-producing power to those which are grown by the skilled farmers of Germany. On the other hand, it is quite certain that if the area of culture be pushed to the south, so as to fall entirely without the limits of the thermal belt, the same fertility of soil, the same fertilization, and the same care in culture will produce beets less rich in sugar, with a lower purity, and yielding less sugar per ton than those grown in the localities first mentioned.

As to how far the successful growth of the sugar-beet industry can be pushed north of the limit of 69°, it may be said that the only condition to be considered in this matter is the possibility of producing and ripening a crop and harvesting it before the rigors of winter set in. The culture of the sugar beet may be very successfully practiced in localities where the mean summer temperature falls even as low as 64°,

provided the latitude is far enough north to get sufficient sunshine to mature the beets before the frosts of autumn. If the autumn be mild and merge gradually into winter, the limit of successful culture will be found where the freezing weather of winter cuts short the time required for the harvesting and siloing of the crop of beets. In the light of the data at present available, therefore, the southern limit of the sugar-beet belt may be regarded as the isotherm of 71° for the three summer months, occasionally pushing 50, 75, or even more miles south of this line, where exceptional conditions of soil and manufacturing facilities are presented. The facts of the case, however, warrant the statement that the safer plan will be not to push south of the isotherm of 71° so long as equally favorable conditions of soil and manufacture are obtainable north of this line of demarcation. It is deemed wise to dwell particularly upon this subject, because of the fact that so many people living south of the isotherm of 71° are vitally interested in this matter and so eager to have the industry established in the neighborhoods in which they live. The conclusions which have been drawn are not meant to discourage experimental work in areas widely remote from those mentioned. It is only just, however, to call attention to the fact that investments of large amounts of capital which result disastrously do more to deter the successful establishment of an industry than a much larger number of successful investments favor it. For instance, in the State of Wisconsin we have an illustration of the financial failure of an attempt to manufacture beet sugar, and as a result of this failure it will be difficult to induce capital to look for investment in Wisconsin in the sugar-beet industry, although the conditions in that State are exceedingly favorable to success. Had it not been for the failure of the factory projected at Menominee Falls, it is quite certain that other capital would be invested in the State at the present time, and instead of the industry being in a stagnant condition it would be advancing on the road toward success. It is extremely important that no mistakes be made from a financial point of view, and that every precaution to avoid these mistakes be observed. When subsequent experimentation shall have demonstrated that there are areas outside, and especially south of the theoretical belt, equally as well suited to the growth of beets sufficiently rich in sugar as those which have been mentioned, it will be time enough to ask capital to seek investment in those localities.

SUGAR BEETS AS CATTLE FOOD.

Thousands of farmers in various parts of the country are growing beets in an experimental way and have no opportunity to dispose of their product to sugar factories. These farmers may, nevertheless, find the growing of small quantities of sugar beets profitable by using the product for cattle food. Following is an analysis lately made in

this laboratory of a sample of sugar beets received from a locality such as is mentioned above:

Composition of fresh beet pulp.

	Fresh pulp.	Dry matter.
	Per cent.	*Per cent.*
Moisture	73.87	.....
Fiber (crude)	1.53	5.89
Ash	1.35	5.18
Ether extract (fat)	.11	.42
Proteids	2.21	8.47
Sugar and other carbohydrates	20.93	80.04
	100.00	100.00

The sample in question contained 73.87 per cent of water and 26.13 per cent of dry matter. The analyses of hundreds of samples of beets in this laboratory show that the average content of fiber, usually called "marc," is about 5 per cent. In the process of analysis all this marc is dissolved except that which is entered above as crude fiber, namely, 1.53 per cent. The difference between this and the 5 per cent average content of marc, namely, 3.47 per cent, shows the quantity of carbohydrate matter not sugar contained in the 20.93 per cent of total sugars and carbohydrates. The quantity of sugar in the sample analyzed was, therefore, 17.46 per cent. Practically all, however, of the carbohydrates, except those represented by the crude fiber, are digestible, so that the soluble marc has practically the same food value as the sugar itself. The ratio of the proteid matter to the digestible carbohydrates plus fat multiplied by $2\frac{1}{4}$, is 9.59. This ratio shows that the food is particularly a fattening one, and could be used to great advantage in preparing fat stock for market. The analysis also indicates that the food, to secure the best results for all-round sustenance, should be fed with some highly nitrogenous ration in order to secure a smaller ratio between the two groups of nutrients. It may be said with perfect confidence that it will be far more profitable for the farmer to grow sugar beets at 12 tons per acre for cattle food than other root crops, such as turnips and ruta-bagas, which will yield double that quantity per acre. The food value of these crops does not depend upon the gross tonnage, but upon the actual nutrients which they contain. Sugar beets contain, as is seen, over 20 per cent of their weight of actual nutrients, while turnips and radishes may contain only from 6 to 12 per cent.

USE OF BEET PULPS FOR CATTLE FOOD.

The residue from beet factories, in the form of the beet pulp, is also a valuable cattle food. In this country no carefully controlled feeding experiments have been conducted with this material, but the question has been studied most thoroughly in Europe, and the data obtained can be used for our guidance. There is practically no difference in chemical composition between the beet pulps obtained in

Europe and in this country, so that the deductions to be drawn from the feeding experiments in that country can be applied with perfect safety to similar work here. At many of the factories in this country practical feeding tests have been made, and with favorable results. Having heard that successful experiments in feeding cattle and sheep had been conducted at the factory of the Pecos Valley Beet Sugar Company, I addressed a letter to the manager of that factory, and received the following reply:

EDDY, N. MEX., *February 21, 1898.*

DEAR SIR: I have your letter of the 14th. Shortly before the close of our campaign, Mr. A. J. Crawford, a large sheep owner of this section, looked into the question of feeding beet pulp to sheep, and finally decided to try a bunch of 500 lambs as an experiment. These lambs were the culls of his flock, and when brought to the feeding pens at the factory were in very poor condition. In a few days they took to the pulp very readily, and are now eating 7 to 10 pounds of pulp per day each, with sufficient hay (alfalfa) as roughening. They have picked up wonderfully during the time they have been here, and Mr. Crawford tells me that they are now the best looking of any he has. He is so well satisfied with the result of his experiment that about a week ago he brought in 2,000 ewes with the intention of feeding them on the pulp during the lambing season. You, of course, are aware that the pulp is a great milk producer, and by feeding it Mr. Crawford will be able to carry both ewes and lambs through in good shape until the grass comes, and, of course, thereby prevent the loss which he would otherwise have to stand of the many ewes and lambs which would die on the range.

When the lambing season is over and we see how the sheep come through I shall be glad to write you fully. Mr. Crawford is anxious to make a contract for all our next year's pulp, and I have no doubt that the feeding of sheep on pulp in this valley will become quite an industry.

Yours, truly,

A. S. GOETZ,
General Manager.

Mr. H. W. WILEY,
Division of Chemistry, Washington, D. C.

It is evident from the above that these practical experiments in feeding, although not controlled by actual chemical analyses, have been eminently successful, and it is not at all unlikely that within a few years our beet factories will be able to contract in advance for all the pulp which they can possibly produce. To illustrate more clearly the value of the pulp and its value for feeding purposes, the following extracts, taken from standard European authorities, are published:

DIFFUSION PULPS OR EXHAUSTED COSSETTES.

The following table contains an average of analyses made by Messrs. Vivien, Lucas, Duvin, Durot, and Dupont as a commission of experts in France:

	Fresh pulp.	Dry material.
	Per cent.	*Per cent.*
Moisture	89.09	.....
Nitrogenous matter	.92	8.43
Digestible carbohydrates	6.52	59.76
Indigestible carbohydrates	1.98	18.15
Fat	.09	.83
Mineral matter	1.40	12.83
	100.00	100.00
Solid matter	10.91	.....

FEEDING EXPERIMENTS WITH BEET PULP.

Extensive tests in feeding pulps have been made at the Francières sugar house of M. Gallois. The following animals were used: (1) Beef cattle, (2) oxen, (3) milch cows, (4) sheep, (5) ewes. Before beginning the tests, these animals were all gradually accustomed to the change from their customary ration to that of diffusion pulp.

(*a*) *Beef cattle.*—Twelve beeves each received every day, in three meals, 52.26 kilograms (115 lbs.) of diffusion pulps, mixed with 3 kilograms of linseed oil cake and 3 kilograms (6.6 lbs.) of chopped alfalfa. Their weight increased an average of 1.004 kilos (2.214 lbs.) per day. If we consider the value of the meat as 0.95 franc ($0.19), that of the oil cake 0.25 franc ($0.05), and that of the alfalfa 0.08 franc ($0.016) per kilogram (2.2 lbs.), we find that the feeding value of the diffusion pulp was 6.58 francs ($1.316) per 1,000 kilograms (2,205 lbs.).

(*b*) *Oxen.*—Four oxen each received the following ration per day: 57.5 kilograms (126.8 lbs.) of diffusion pulp mixed with 5 kilograms (12 lbs.) of alfalfa and 1 kilogram (2.2 lbs.) of linseed-oil cake. These cattle decreased somewhat in weight in the first fifteen days, and did less than the usual amount of work, but in the second fifteen days they had entirely recovered. The trial continued two and a half months. In making a calculation analagous to that above, the value of the diffusion pulp was 4.78 francs ($0.956) per 1,000 kilograms (2,205 lbs.).

(*c*) *Milch cows.*—The test with milch cows lasted thirty days. Two cows were employed—one Flemish and the other Dutch. Before the tests the cattle were fed on dry alfalfa with a small quantity of beet pulps produced by the hydraulic-press method. The cows were each given, per day, 45 kilograms (99.2 lbs.) of diffusion pulp with 2 kilograms (4.4 lbs.) of alfalfa. The tests demonstrated that the diffusion pulp is more advantageous as regards lactation than in the production of flesh.

Cows fed on diffusion pulps.

Date.	Cream per 100 cc. of milk.	
	Cow No. 1.	Cow No. 2.
April 27	8.00	7.00
May 1	7.50	8.00
May 12	7.50	8.00
May 19	7.50	8.00

From these tests it was shown that the milk of the cows fed from diffusion pulp contained an average of 7.68 per cent of cream. The butter produced from this milk did not have the peculiar disagreeable odor which is present in that from cows fed on press pulps.

(*d*) *Sheep.*—In this test twenty merino sheep were fed on diffusion pulp. The following table shows the result of this test and the rations fed per animal:

	Kilos.		
Weight:			
April 4	948	=2,085.6	pounds.
April 26	1,008	=2,217.6	pounds.
Total increase	60	= 132.0	pounds.
Increase per sheep per day	0.137	= .3	pounds.
Average rations per head:			
Pulp	5.4	= 11.88	pounds.
Linseed-oil cake	.2	= .44	pounds.
Chopped alfalfa	.5	= 1.10	pounds.

It was not necessary to make other additions to the diffusion pulp, since the sheep ate it with avidity. With the aid of these figures we may calculate the value of the pulp as follows:

The sheep gained per day 0.137 kilogram (.3 lb.) in meat, which at 1 franc ($0.20) per kilo (2.2 lbs.) equals 0.137 franc ($0.027). They consumed a ration, exclusive of the pulp, costing 0.09 franc, therefore the value of the 5.4 kilos (11.9 lbs.) of diffusion pulp was 0.047 ($0.01), or 8.70 francs ($1.74) per 1,000 kilograms (2,205 lbs.).

Experiments made with ewes.—The ewes were obtained from a flock from which the lambs had just been separated. In feeding the ewes, to which a somewhat larger ration was given, the value of the pulp was found to be 6.03 francs ($1.206) per 1,000 kilograms (2,205 lbs.). Taking all of these elements into account, the experts estimated definitely the value of 1,000 kilograms (2,205 lbs.) of diffusion pulp to be 5.55 francs ($1.11). They also demonstrated that diffusion pulps keep perfectly.

Not taking into account questions of transportation, etc., the value of diffusion pulp was estimated at 6.10 francs ($1.22) per 1,000 kilograms (2,205 lbs.). Basing a conclusion upon the chemical analysis of the pulp, a value of 6.44 francs ($1.288) was obtained, as compared with the 6.10 francs ($1.22) per 1,000 kilograms (2,205 lbs.) given by experiments.

EXPERIMENTS BY ANDOUARD AND DÉZAUNAI.

(Sucrerie Belge, Vol. 12, No. 7.)

In tests in feeding diffusion pulp to milch cows this pulp was given in a ration, first of 27 kilograms (59.5 lbs.) and later 55 kilograms (121.3 lbs.) per day, and produced immediately an increase of approximately 32 per cent in the yield of milk. It appeared, however, to be without influence on the richness of the milk in casein and mineral matter, but produced an increase in the yield of butter of 12.4 per cent, and in that of the sugar of 24.63 per cent over the previous proportions of these constituents. It, however, gave the milk a less agreeable taste and a

certain predisposition to an acid fermentation. The butter, therefore, would probably not be of excellent quality.

*Analyses of diffusion pulps before ensilage.**

Constituents.	Maercker.	Kühn.
	Per cent.	*Per cent.*
Water	89.77	88.9
Dry matter	10.23	11.1
Ash	.58	.9
Fat	.05	.1
Crude fiber	2.39	2.5
Crude protein	.89	.9
Nitrogen-free extract	6.32	6.7

*Diffusion pulps after having been stored in the silos.**

Constituents.	Maercker.	Kühn.
	Per cent.	*Per cent.*
Water	88.52	87.5
Dry matter	11.48	12.5
Ash	1.09	.9
Fat	.11	.1
Crude fiber	2.80	3.0
Crude protein	1.07	1.2
Nitrogen-free extract	6.41	7.3

* Sachs' Revue Universelle des Progrès de la Fabrication du Sucre, 1, 428.

Analysis of diffusion pulps, by Pellet.

Constituents.	Pressed pulp.	Dry material.
	Per cent.	*Per cent.*
Water	88.06	.....
Nitrogenous matter	.84	7.04
Digestible carbohydrates	7.30	61.14
Indigestible carbohydrates	2.46	20.60
Fat	.06	.50
Soluble mineral matter	.43	3.60
Insoluble mineral matter	.85	7.12
	100.00	100.00
Dry matter	11.94	.....

Maercker (Sucrerie Belge, vol. 11, page 464) determined that siloed pulps, in addition to losing water, also lost a considerable portion of their dry matter. This is shown in the following statement of the analysis of pulps which were siloed for five months, in which time they lost the following percentages:

Thirty-seven and eight-tenths of nitrogen free extract, 25.5 of nitrogenous matter and 29.6 of the fiber which they contained: The pulps gained, on the contrary, in fat, owing to the lactic and butyric fermentations. The losses were due to decomposition, and not to entrainment in the moisture lost.

*Analyses of diffusion pulp, by Vivien.**

Constituents.	Pressed pulp.	Dry material
	Per cent.	*Per cent*
Digestible proteids (nitrogen X 6.25)	0.64	7.73
Indigestible proteids (amid nitrogen X 9)	.04	.48
Nitrate of potassium	.05	.60
Digestible carbohydrates	4.07	49.15
Cellulose and indigestible carbohydrates	1.92	23.19
Fat	.05	.60
Sugar	.54	6.52
Assimilable mineral matter	.35	4.23
Indigestible mineral matter	.61	7.37
Water	91.72	.....
	100.00	100.00

*Analyses of diffusion pulp, by Pellet.**

Constituents.	Pressed pulp.	Dry material.
	Per cent.	*Per cent.*
Water	88.88	.....
Organic matter	9.95	89.50
Soluble inorganic matter	.57	5.13
Insoluble inorganic matter	.60	5.40
	100.00	100.00
Acidity (expressed as acetic acid)	1.01	9.08
Total nitrogen	.147	1.32
Insoluble nitrogen (at the boiling point of water)	.111	.....

* Sachs' Revue Universelle des Progrès de la Fabrication du sucre, 1, 429.

The pulps diminished in weight in the silos, the diffusion pulps losing 6 per cent per month. At the same time there was a diminution in the weight of the dry matter, approximately 1 per cent of the diffusion pulp.

It is evident from the above data that the value of the pulp from beet-sugar factories, especially in thickly settled countries and in those regions where the dairy interests are prominent, will prove of no inconsiderable advantage in the successful introduction of the beet sugar industry and its rapid advancement. Beet pulps form a wholesome and nutritious, though a somewhat poorly balanced ration. Their chief nutriment is found in the carbohydrates, composing the marc of the beet and including the unextracted sugar, and in the proteid nitrogenous matters, and a large percentage of these is easily digested. While beet pulp is not suitable for the entire food of the animal, it can be made a principal part thereof, varying its proportions with the nature of the effect desired to be produced. Experience has shown that it is especially relished by dairy cattle, produces an abundant supply of milk, and where properly preserved and fed, it can be used in great abundance without imparting to the milk, butter, or cheese any unpleasant flavor.

SUMMARY OF DATA COLLECTED IN PREVIOUS YEARS.

In order to present data covering as wide a field as possible, and including the experiments of several seasons, the following table has

been compiled from the reports of the Division of Chemistry and from the bulletins of the various State experiment stations:

Analyses of sugar beets grown in various States.

[A compilation of the analytical data obtained at the various State experiment stations for the years 1888 to 1897, inclusive, and at the United States Department of Agriculture for the years 1884 to 1897, inclusive.]

State.	Analyses by the United States Department of Agriculture.					Analyses by the State experiment stations.			
	Year.	Number of samples.	Average weight.	Sugar in beet.	Purity coefficient.	Number of samples.	Average weight.	Sugar in beet.	Purity coefficient.
			Ounces.	*Per ct.*			*Ounces.*	*Per ct.*	
Alabama	1893	.....	.....	5.9	66.7	.....	.....	.....	.....
Arizona	1891	2	51	7.7	56.9	.....	.....	.....	.....
	1897	7	23	9.3	70.4	157	.....	*a* 8.1	61.8
Average	.....	9	29	9.0	67.4	157	.....	8.1	61.8
Arkansas	1891	2	40	6.4	58.8	.....	.....	.....	.....
	1892	3	12	9.4	64.7	.....	.....	.....	.....
	1897	2	18	11.3	71.5	.....	.....	.....	.....
Average	.....	7	22	9.1	65.0	.....	.....	.....	.....
California	1884	71	19	13.7	85.3	.....	.....	.....	.....
	1888	.....	.....	.....	.....	5	.....	10.7	.....
	1889	.....	.....	.....	.....	14	19	12.1	77.7
	1890	4	13	14.7	84.6	18	17	10.7	73.0
	1891	8	48	11.1	75.8	.....	.....	*b* 13.0	
	1892	4	14	14.7	77.6	.....	.....	*b* 14.0	
	1893	.....	.....	.....	.....	.....	.....	*b* 14.0	
	1894	.....	.....	.....	.....	.....	.....	*b* 15.0	
	1895	.....	.....	.....	.....	.....	.....	*b* 15.0	
	1896	.....	.....	.....	.....	.....	.....	*b* 14.0	
	1897	1	26	16.8	.....	.....	.....	.....	.....
Average	.....	88	21	13.6	85.3	37	18	11.2	75.1
Colorado	1888	.....	.....	.....	.....	.....	.....	9.9	.....
	1889	.....	.....	.....	.....	37	.....	10.2	.....
	1890	29	20	12.5	76.1	73	25	11.0	83.0
	1891	51	26	13.1	76.1	4	.....	*13.5	79.3
	1892	170	18	14.8	81.7	16	.....	*13.8	80.6
	1893	18	17	13.2	74.9	.....	.....	.....	.....
	1897	174	20	13.6	76.7	12	.....	14.3	79.7
Average	.....	442	20	13.9	78.4	142	25	11.5	82.1
Connecticut	1890	2	14	9.7	76.1	.....	.....	.....	.....
	1891	5	27	10.8	77.3	.....	.....	.....	.....
Average	.....	7	23	10.5	77.0	.....	.....	.....	.....
Georgia	1891	2	12	11.1	64.9	.....	.....	.....	.....
Idaho	1890	1	4	8.0	68.3	.....	.....	.....	.....
	1891	1	15	12.7	74.9	.....	.....	.....	.....
	1892	2	34	14.7	79.1	.....	.....	.....	.....
	1893	2	78	10.2	76.2	.....	.....	.....	.....
	1894	.....	.....	.....	.....	192	.....	13.7	76.1
	1895	.....	.....	.....	.....	342	.....	15.2	79.9
	1896	.....	.....	.....	.....	60	.....	14.2	77.3
	1897	7	21	15.5	79.4	41	.....	15.2	87.6
Average	.....	13	30	13.8	77.6	635	.....	14.6	80.2

* The sign * indicates that the number given is 0.95× per cent of sugar reported since it was doubtful whether the per cent of sugar was expressed in terms of the weight of the juice or that of the beet, though probably the former.

a Analyses of Kleinwanzlebener only show: 32 samples, sugar 11.8, purity 73.6.

b From report made on the total crop by the Chino Valley Beet Sugar Company.

Analyses of sugar beets grown in various States—Continued.

State.	Analyses by the United States Department of Agriculture.					Analyses by the State experiment stations.			
	Year.	Number of samples.	Average weight.	Sugar in beet.	Purity coefficient.	Number of samples.	Average weight.	Sugar in beet.	Purity coefficient.
			Ounces.	*Per ct*			*Ounces.*	*Per ct.*	
Illinois	1890	8	31	10.3	72.1	.....	.....	.....	.....
	1891	36	32	11.7	76.4	.....	.....	.....	.....
	1892	59	15	10.9	75.2	.....	.....	.....	.....
	1897	32	17	13.1	75.5	312	20	11.9	76.4
Average	.....	135	21	11.6	75.4	312	20	11.9	76.4
Indiana	1888	.....	.....	.....	.....	5	.....	12.2	.....
	1889	.....	.....	.....	.....	10	.....	11.9	.....
	1890	56	23	10.7	72.7	26	7	9.1	.....
	1891	77	27	11.6	76.9	131	*a* 20	12.0	78.8
	1892	57	14	11.2	72.5	95	12	11.1	76.8
	1893	4	10	10.7	73.1	49	12	11.8	79.3
	1894	.....	.....	.....	.....	84	25	11.8	78.8
	1897	103	14	13.1	78.9	205	18	12.0	80.7
Average	.....	297	19	11.9	75.9	605	17	11.7	79.2
Indian Territory	1891	1	27	11.6	76.9	.....	.....	.....	.....
Iowa	1888	.....	.....	.....	.....	4	17	11.9	76.5
	1889	.....	.....	.....	.....	12	34	9.9	64.9
	1890	30	22	11.8	74.5	34	33	10.7	71.4
	1891	321	30	11.8	75.7	503	16	12.1	74.0
	1892	30	24	10.9	76.2	404	21	11.6	72.9
	1893	7	17	12.8	75.8	563	19	11.9	76.1
	1894	.....	.....	.....	.....	150	19	11.5	74.9
	1897	130	18	13.3	73.7	642	19	12.4	76.6
Average	.....	518	26	12.1	75.2	2,312	19	12.0	75.0
Kansas	1889	.....	.....	.....	.....	7	.....	8.9	69.7
	1890	22	32	8.3	69.3	16	31	7.9	.....
	1891	36	33	10.7	68.2	183	19	9.6	70.6
	1892	22	25	11.1	74.2	115	21	10.2	73.4
	1893	1	.....	14.3	72.8	22	21	10.1	71.8
	1897	41	27	11.4	73.8	158	17	11.9	77.0
Average	.....	122	29	10.6	71.4	501	19	10.4	73.4
Kentucky	1891	3	34	9.1	63.7	.....	.....	.....	.....
	1892	4	13	8.9	77.2	.....	.....	.....	.....
	1897	6	16	11.9	71.5	.....	.....	.....	.....
Average	.....	13	19	10.3	72.2	.....	.....	.....	.....
Louisiana	1893	3	12	8.9	68.3	.....	.....	.....	.....
Maryland	1890	83	15	12.2	79.3	5	10	12.2	79.7
	1891	2	16	7.4	68.5	.....	.....	.....	.....
	1897	29	19	11.4	79.1	.....	.....	.....	.....
Average	.....	114	16	11.9	79.1	5	10	12.2	79.7
Massachusetts	1889	.....	.....	.....	.....	10	.....	12.2	.....
	1890	6	16	12.0	82.8	6	17	13.4	*b* 77.1
	1891	.....	.....	.....	.....	6	17	13.4	78.1
Average	.....	6	16	12.0	82.8	22	17	12.8	77.6
Michigan	1889	.....	.....	.....	.....	6	*c* 19	12.6	.....
	1890	30	31	12.0	78.4	.....	.....	.....	.....
	1891	50	32	12.6	78.0	229	.....	13.3	86.2
	1892	71	19	14.1	83.4	.....	.....	.....	.....
	1893	88	15	13.3	82.1	.....	.....	.....	.....
	1897	450	22	14.7	81.1	465	27	16 4	84.0
Average	.....	689	22	14.2	81.1	700	27	15.5	84.7

a Average weight of 71 samples. *b* Purity of but 1 sample.
c Average weight of 2 samples.

Analyses of sugar beets grown in various States—Continued.

State.	Analyses by the United States Department of Agriculture.					Analyses by the State experiment stations.			
	Year.	Number of samples.	Average weight.	Sugar in beet.	Purity coefficient.	Number of samples.	Average weight.	Sugar in beet.	Purity coefficient.
			Ounces.	*Per ct.*			*Ounces.*	*Per ct.*	
Minnesota	1890	107	30	11.8	75.2	55	.....	*12.3	76.5
	1891	41	29	12.4	75.7	467	*a* 23	*13.0	79.7
	1892	22	29	12.2	78.1	180	17	14.3	85.5
	1893	7	60	10.8	70.8	.....	.....	.....	.....
	1897	49	24	11.0	79.2	143	17	13.1	81.8
Average	.....	226	29	11.7	76.3	845	19	13.2	81.1
Missouri	1890	2	21	8.4	66.7	5	17	13.4	.....
	1891	67	20	10.4	62.4	59	28	9.3	67.3
	1892	13	33	8.1	63.4	.....	.....	.....	.....
	1897	324	20	11.7	73.5	304	26	10.6	71.0
Average	.....	406	20	11.4	71.6	368	26	10.4	70.4
Montana	1891	35	25	13.2	76.8	.....	.....	.....	.....
	1892	6	22	10.9	72.8	.....	.....	.....	.....
	1893	2	15	14.3	75.0	.....	.....	.....	.....
	1897	4	20	14.4	77.8	70	23	14.7	77.0
Average	.....	47	24	13.1	76.3	70	23	14.7	77.0
Nebraska	1888	.....	.....	.....	.....	9	.....	12.7	.....
	1889	.....	.....	.....	.....	159	46	10.3	54.5
	1890	269	20	11.8	71.9	462	17	*12.3	73.9
	1891	62	35	11.7	75.3	218	*b* 23	12.8	77.9
	1892	27	21	14.2	79.3	98	17	9.8	72.4
	1893	8	17	10.1	69.7	(*c*)	.....	11.3	77.0
	1895	.....	.....	.....	.....	637	.....	12.1	76.9
	1897	13	29	12.9	76.9	106	.....	11.7	75.0
Average	.....	379	23	12.0	73.1	1,689	22	11.9	73.7
Nevada	1891	18	11	17.2	88.0	222	25	12.5	76.9
	1892	81	13	15.9	83.4	221	18	14.8	80.8
	1893	.....	.....	.....	.....	51	20	13.6	80.8
	1894	.....	.....	.....	.....	.....	.....	.....	.....
	1895	.....	.....	.....	.....	176	.....	13.1	*d* 77.8
	1896	.....	.....	.....	.....	.....	.....	.....	.....
	1897	21	18	18.3	81.4	10	19	18.9	.....
Average	.....	120	14	16.5	83.7	680	21	13.6	78.7
New Hampshire	1891	1	19	11.6	80.0	.....	.....	.....	.....
New Jersey	1891	1	17	7.3	70.8	.....	.....	.....	.....
	1893	.....	.....	.....	.....	8	.....	11.7	76.2
	1897	31	16	14.2	81.4	.....	.....	.....	.....
Average	.....	32	16	14.0	81.1	8	.....	11.7	76.2
New Mexico	1891	17	28	13.8	74.8	.....	.....	.....	.....
	1892	29	19	15.3	83.2	3	.....	*17.0	.....
	1897	3	13	17.2	82.0	219	26	13.2	.....
Average	.....	49	22	14.9	80.2	222	26	13.3	.....

* The sign * indicates that the number given is 0.95× per cent of sugar reported since it was doubtful whether the per cent of sugar was expressed in terms of the weight of the juice or that of the beet, though probably the former.

a Average weight of 229 samples.

b Average weight of 88 samples.

c Analyses reported by the Standard Cattle Company.

d Averages for 1893 to 1896, inclusive.

Analyses of sugar beets grown in various States—Continued.

State.	Analyses by the United States Department of Agriculture.					Analyses by the State experiment stations.			
	Year.	Number of samples.	Average weight.	Sugar in beet.	Purity coefficient.	Number of samples.	Average weight.	Sugar in beet.	Purity coefficient.
			Ounces.	*Per ct.*			*Ounces.*	*Per ct.*	
New York	1889	.....	.....	.....	.....	6	.....	9.9	.....
	1890	10	15	12.1	78.0	.....	.....	.....	.....
	1891	4	32	11.6	76.8	.....	.....	.....	.....
	1892	8	22	15.4	85.9	.....	.....	.....	.....
	1893	.....	.....	.....	.....	29	38	12.9	.....
	1897	225	21	15.0	82.4	562	a 16	15.9	83.2
Average	.....	247	21	14.8	82.2	591	20	15.7	83.2
North Carolina	1892	4	4	9.0	73.4	.....	.....	.....	.....
	1893	.....	.....	4.1	52.1	.....	.....	.....	.....
	1897	7	23	9.1	75.3	.....	.....	.....	.....
Average	.....	11	16	9.1	74.6	.....	.....	.....	.....
North Dakota	1890	24	25	13.4	71.2	9	.....	13.8	.....
	1891	11	23	11.8	73.2	129	29	10.9	73.9
	1892	11	24	12.9	76.5	.....	.....	.....	.....
	1893	2	27	14.0	80.7	.....	.....	.....	.....
	1897	4	28	10.5	81.2	.....	.....	.....	.....
Average	.....	52	25	12.8	73.9	138	29	11.1	73.9
Ohio	1890	15	26	9.8	76.0	.....	.....	.....	.....
	1891	66	31	11.3	73.5	24	.....	9.8	.....
	1892	102	17	14.2	80.2	.....	.....	.....	.....
	1897	68	22	13.8	79.1	554	31	13.3	78.7
Average	.....	251	23	13.1	77.9	578	31	13.2	78.7
Oklahoma	1891	1	48	6.4	53.3	.....	.....	.....	.....
	1897	1	10	11.8	72.5	21	.....	11.4	65.3
Average	.....	2	29	9.1	62.9	21	.....	11.4	65.3
Oregon	1890	2	20	15.1	73.4	37	b 26	11.2	.....
	1891	35	34	12.7	81.1	98	22	12.6	78.4
	1892	12	19	14.2	80.2	65	27	14.4	82.7
	1893	.....	.....	.....	.....	.....	.....	.....	.....
	1894	.....	.....	.....	.....	.....	.....	.....	.....
	1895	.....	.....	.....	.....	23	.....	14.3	c 89.8
	1896	.....	.....	.....	.....	.....	.....	.....	.....
Average	.....	49	30	13.2	80.6	223	24	13.1	81.3
Pennsylvania	1890	10	27	8.0	73.8	.....	.....	.....	.....
	1891	7	22	13.3	78.7	.....	.....	.....	.....
	1892	8	13	10.8	75.8	.....	.....	.....	.....
	1893	1	.....	11.0	78.9	.....	.....	.....	.....
	1897	59	18	13.8	79.5	.....	.....	.....	.....
Average	.....	85	19	12.8	78.4	.....	.....	.....	.....
Rhode Island	1897	2	21	11.9	74.2	.....	.....	.....	.....
South Carolina	1892	.....	.....	.....	.....	3	19	5.8	54.7
	1893	.....	.....	.....	.....	15	15	4.9	.....
	1894	.....	.....	.....	.....	71	23	5.9	.....
	1897	13	17	9.9	79.9	.....	.....	.....	.....
Average	.....	13	17	9.9	79.9	89	22	5.7	54.7

a Average weight of 137 samples. *b* Average weight of 2 samples.
c Averages for 1893 to 1896, inclusive.

Analyses of sugar beets grown in various States—Continued.

State.	Analyses by the United States Department of Agriculture.					Analyses by the State experiment stations.			
	Year.	Number of samples.	Average weight.	Sugar in beet.	Purity coefficient.	Number of samples.	Average weight.	Sugar in beet.	Purity coefficient.
			Ounces.	*Per ct.*			*Ounces.*	*Per ct.*	
South Dakota	1889	.....	.....	.....	.....	17	.....	9.1	.....
	1890	21	20	13.1	78.6	58	.....	14.2	74.7
	1891	202	22	12.5	75.3	1,264	25	11.9	73.3
	1892	67	20	13.1	75.5	680	19	14.2	80.7
	1897	5	17	15.1	83.2	337	14	15.5	85.6
Average	.....	295	21	12.7	75.7	2,356	22	13.1	77.3
Tennessee	1891	5	20	8.8	65.8	.....	.....	.....	.....
	1892	1	10	9.4	72.4	.....	.....	.....	.....
	1894	.....	.....	.....	.....	22	22	9.5	75.1
	1897	17	11	10.8	71.9	8	4	12.0	.....
Average	.....	23	13	10.3	70.6	30	17	10.2	75.1
Texas	1890	2	38	10.0	69.3	.....	.....	.....	.....
	1891	10	23	10.3	69.1	.....	.....	.....	.....
	1897	11	22	12.6	76.5	14	34	8.0	56.3
Average	.....	23	24	11.4	72.7	14	34	8.0	56.3
Utah	1890	.....	.....	.....	.....	21	.....	15.3	86.1
	1891	.....	.....	.....	.....	.....	.....	[a]11.0	80.0
	1892	.....	.....	.....	.....	43	27	*12.5	82.2
	1893	.....	.....	.....	.....	.....	.....	[a]11.6	79.5
	1894	.....	.....	.....	.....	.....	.....	[a]12.7	80.2
	1895	.....	.....	.....	.....	.....	.....	[a]13.5	81.5
	1896	.....	.....	.....	.....	.....	.....	[a]13.9	81.8
	1897	35	20	14.3	81.1	.....	.....	.....	.....
Average	.....	35	20	14.3	81.1	64	27	13.4	83.5
Vermont	1897	8	22	14.2	84.1	32	17	16.3	84.2
Virginia	1890	20	15	10.8	74.0	.....	.....	.....	.....
	1891	72	21	11.1	76.0	.....	.....	.....	.....
	1892	13	12	12.0	79.6	.....	.....	.....	.....
	1893	14	16	13.3	83.9	.....	.....	.....	.....
	1897	34	21	11.6	76.2	5	[b]21	11.6	.....
Average	.....	153	19	11.4	76.8	5	21	11.6	.....
Washington	1890	1	16	15.2	84.2	.....	.....	.....	.....
	1891	11	18	14.5	83.9	.....	.....	.....	.....
	1892	31	18	14.5	76.8	.....	.....	.....	.....
	1893	183	28	12.3	74.0	.....	.....	.....	.....
	1894	.....	.....	.....	.....	1,666	25	*13.5	82.6
	1895	.....	.....	.....	.....	521	17	16.2	87.9
	1896	.....	.....	.....	.....	211	6	13.4	80.9
	1897	34	27	13.7	80.7	60	23	13.6	75.7
Average	.....	260	26	12.8	75.7	2,458	22	14.1	83.4
West Virginia	1892	12	14	11.3	68.5	.....	.....	.....	.....
	1897	14	19	15.4	80.4	.....	.....	.....	.....
Average	.....	26	17	13.5	74.9	.....	.....	.....	.....

* The sign * indicates that the number given is 0.95× per cent of sugar reported since it was doubtful whether the per cent of sugar was expressed in terms of the weight of the juice or that of the beet, though probably the former.

[a] Report made on total crop by Utah Sugar Company, 1891–1896.

[b] Average weight (net) estimated from average gross weight.

Analyses of sugar beets grown in various States—Continued.

State.	Analyses by the United States Department of Agriculture.					Analyses by the State experiment stations.			
	Year	Number of samples.	Average weight.	Sugar in beet.	Purity coefficient.	Number of samples.	Average weight.	Sugar in beet.	Purity coefficient.
			Ounces.	*Per ct.*			*Ounces.*	*Per ct.*	
Wisconsin	1890	10	21	12.8	81.3	94	35	11.7	76.3
	1891	432	26	11.1	75.8	373	32	11.9	76.2
	1892	21	22	12.7	77.8	61	26	15.2	81.6
	1897	42	15	15.8	83.3	1,663	.....	12.1	74.1
Average	.....	505	25	11.4	76.6	2,191	32	12.1	74.7
Wyoming	1890	5	26	15.1	78.8	.....	.....	.....	.....
	1891	18	12	13.5	78.1	55	11	15.4	77.8
	1892	6	8	15.2	85.2	71	14	15.9	78.7
	1893	48	19	15.9	80.5	33	.....	16.2	80.9
	1897	34	19	17.2	82.3	.....	.....	.....	.....
Average	.....	111	18	15.8	80.8	159	13	15.8	78.8

NOTES ON PRECEDING TABLE.

In a few instances analyses reported to the stations by sugar companies or organizations designed for the promotion of the sugar industry have been included. It is noticeable that in many States but few analyses have been made. In view of this fact, it is well to be cautious in accepting the results of these few analyses as being representative of the beets grown in the State.

The reports from the State of California are especially incomplete. Most of the analyses reported are from data obtained in the laboratory of the Chino Valley Beet Sugar Company. In view of the fact that California has several very large and very successful factories, we do not regard the data included here of great value in judging of the State as a producer of high-grade sugar beets. We have data of factory averages obtained in California representing in some cases more than 100,000 tons of beets, showing that the State produces beets of very high sugar content. Factory averages have been reported this year higher than 15 per cent of sugar in the beets. It will be noticed that in most instances the results obtained by the Department of Agriculture corroborate those obtained in the stations.

A notable exception to this is in the tabulation of the results obtained with beets grown in the State of Washington. The Department of Agriculture, however, has only made about one-tenth as many analyses of Washington beets as the station. The average of the results of the large number of Washington beets analyzed shows that this State is destined to be a large producer of sugar.

In many cases the averages are based on very incomplete data, and therefore must not be considered strictly representative of all the results included. In figuring the general averages each annual average is weighted in proportion to the number of samples it represents.

INVESTIGATIONS IN SEED PRODUCTION.

The second line of experiments carried on by the Department of Agriculture during the season of 1897 was devoted especially to the culture of high-grade beets in cooperation with a few of the agricultural experiment stations. The localities selected for the experiments were such as would represent as wide a range as possible of climatic conditions, and be compatible with the time at the disposal of the Chemist of the Department for doing the work, and with the quantity of high-grade seeds on hand. It was not deemed advisable to go into the arid regions with these experiments, because it was not possible, in the short time at our disposal, to make proper preparations for the conduct of our work. Under authority of the Secretary of Agriculture the Chemist of the Department made arrangements with the following experiment stations to conduct the work under as nearly as possible identical conditions, except those pertaining to climate:

The agricultural experiment station of New York, at Geneva.
The agricultural experiment station of Indiana, at Lafayette.
The agricultural experiment station of Wisconsin, at Madison.
The agricultural experiment station of Iowa, at Ames.
The agricultural experiment station of Kentucky, at Lexington.
The agricultural experiment station of Tennessee, at Knoxville.

In order that the experiments might be conducted on plots of equal area, each director of the stations mentioned above was furnished with

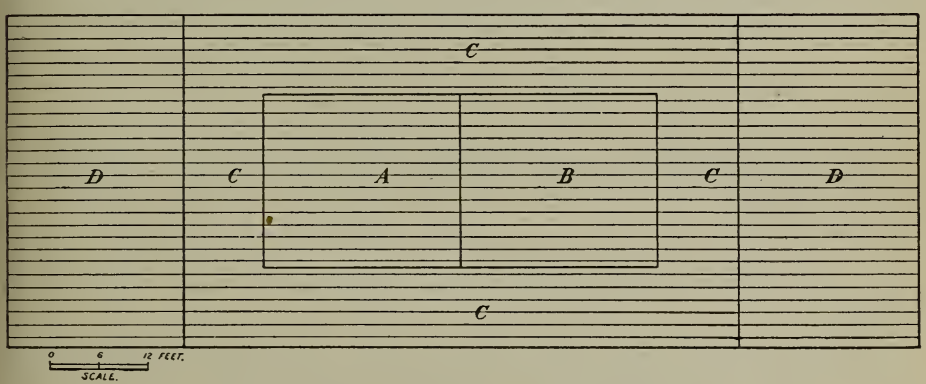

FIG. 2—Plot for guidance in planting sugar beets.

a diagram showing the manner in which it was thought most advisable to plant the different varieties of seeds. The diagram shown in figure 2 was accompanied by the following descriptive letter:

UNITED STATES DEPARTMENT OF AGRICULTURE,
DIVISION OF CHEMISTRY,
Washington, D. C., April 23, 1897.

DEAR SIR: For the sake of having complete uniformity in the comparative tests of high-grade beet seeds, I send herewith a diagram for the purpose of guiding you in the preparation of the plots and in the planting of the seed. The object of this diagram is to secure the planting of the high-grade seed in the interior smaller plots AB, each one of which has almost exactly the area of 500 square feet. If preferred the

size of the interior plots may be varied so as to make each of them exactly one one-hundredth of an acre, namely, 435.6 square feet. I think it would be better, however, to keep the interior plots AB each 500 square feet, as they fit the rows as indicated by the horizontal line, allowing exactly 14 rows in the plots, of a total length, including both interior plots, of about 47.6 feet. The interior plots AB are surrounded by a border CCCC, which is to be planted with the high-grade commercial seeds which I shall send you. The end plots DD are to be planted with the same kind of high-grade commercial seeds as CCCC, but these end plots are not necessary to the success of the experiments. The object of the border CCCC is to surround the high-grade seeds AA with beets grown under the same conditions, so that the exterior rows of the plots AA may be subjected to the normal conditions of beet growth, which would not be the case if such small plots were left unprotected. The scale of these plots is 1 inch=12 feet. I think it is important that the soil of the plots be prepared in accordance with the directions contained in Bulletin No. 52, a copy of which I transmit herewith. The plowing and subsoiling should loosen the ground to a depth of not less than 16, and, better, to a depth of 18 inches, and the surface of the soil, after plowing and subsoiling, should be reduced to perfect tilth.

I am now awaiting the remainder of the high-grade seeds, which I expect in a few days. There will be two varieties of the high-grade seeds, one to be planted in Plot A and the other in Plot B. All the seeds sent you will be plainly marked, so that no mistake can be made. The quantity of seed required for plots A and B will be about 5 ounces. I think it best that the interior plots A and B at least should be planted by hand. The number of seeds in the 5 ounces being known, they should be planted in groups at intervals of 9 inches; that is, in such a way as to secure one good, vigorous plant at about every 9 inches in the row after thinning. Five ounces of seed will contain approximately 5,000 seeds, and in the two plots A and B there will be 888 hills, which gives approximately nearly 6 seeds to a hill. In this case the planting would be accomplished as follows: Six seeds placed in the row at distances of 1 inch apart followed by an interval of 3 inches, then again 6 seeds at intervals of 1 inch, and so on. This grouping is shown in the following line:

9 in. 9 in.

. . . .

Of course the spacing will vary according to the number of seeds to be planted.

If there be anything in connection with the diagram that you do not understand please let me know.

Respectfully, H. W. WILEY, *Chief of Division.*

The high-grade seeds furnished for planting the above plots were as follows:

(1) The Vilmorin Improved, grown at the experiment station of the United States Department of Agriculture at Schuyler, Nebr., in 1893. This station was abolished in the autumn of that year by Secretary Morton, and the principal part of all the high-grade seeds on hand was sold to the Oxnard Beet Sugar Company, of Grand Island, Nebr. A small portion of each variety was retained, however, in the hope that at some day the experiments might be reestablished. When subjected to a germination test, however, of all the varieties which had been preserved, only the Vilmorin Improved showed unimpaired vitality. All the other varieties grown at Schuyler showed a vitality too low to warrant planting.

(2) Original Kleinwanzlebener, grown by Kühn & Co., Naarden, near Amsterdam, Holland. These seeds were from specially analyzed mothers, showing the very highest qualities for seed production.

(3) High-grade commercial seed, grown by F. Demesmay, Cysoing, France. These seeds were not grown from specially analyzed mothers, but represented the high-grade commercial seeds produced at that place.

These three varieties were furnished for planting in Section B. There were also sent at the same time some of the high-grade commercial Kleinwanzlebener and Vilmorin's La Plus Riche for planting sections CCCC and DD, as indicated in the diagram. These seeds were sent to the various stations specified above on the 24th of April, 1897. The high-grade seeds which were to be used in planting Section A had not yet been received, and were not forwarded at that time.

The seeds ordered from Europe did not arrive until May 15, and were sent at once to the several stations on that day. In addition, seeds were received from August Rölker & Sons, representing Dippe Brothers, at New York, and from Martin Grashoff, of Quedlinburg. These seeds were also sent for planting the margins of the plot indicated above.

In the general instructions given to the directors of the stations it will be noticed that all the details of the work were left to be decided by them at the proper time, as any directions for time of planting, etc., would be but futile. Each one of the directors undertook to do the work strictly in accordance with the instructions provided in so far as the preparation of the land, planting, cultivation, and harvesting of the samples were concerned. The Chemist of the Department visited three of the stations during the season and conferred personally with the directors in regard to the progress of their work. The other directors were communicated with only by letter.

In the analytical work samples were selected according to instructions and sent to the Department of Agriculture, and others were analyzed in the laboratories of the collaborating experiment stations.

On May 6, the high-grade seeds not yet having arrived from Europe, I sent to each of the stations for planting Section A some high-grade seeds grown by Martin Grashoff, of Quedlinburg, obtained from Mr. Jellinek, an agent of the grower in this country. I suggested that Section A be planted with this seed, and then if the other seed expected from Germany came in time the plants could be dug out and the section replanted. The name of the seeds sent for planting Section A was White Improved Imperial Elite, which were produced by a cross of another variety with the Kleinwanzlebener. Directions for planting the seeds according to the plot were furnished each director.

The additional quantity of high-grade sugar-beet seed ordered from Dippe Brothers, Quedlinburg, Germany, was received and distributed to the stations on the 17th of May. In most cases the beets in Section A which were previously planted were not dug out, but the new seeds were planted in other localities.

The conditions of growth varied greatly in the different localities during the season. At the New York station the spring was backward and cold, and the planting and first development of the beets were

delayed. The subsequent conditions were favorable to good growth. The beets received no backset, and reached a fair maturity by the 1st of October. The autumn was mild and cool, and dry enough to prevent second growth, so that the beets could be left in the ground with perfect security until late in November.

At the Indiana station less favorable conditions obtained. A poor stand of the beets was secured in many instances where a perfect stand was secured at the New York station. The early leaves were badly eaten by an insect, and this prevented the early rapid development of the plant. Subsequently a period of extreme drought set in, lasting for nearly two months—during July and August. The result of all these unfavorable conditions was practically a complete failure of the crop, so that even in the case of the beets which were secured there were evidences of arrested development. The general result of the experiment was exceedingly discouraging.

At the Wisconsin station the field which was selected for the growth of the beets was not particularly well suited to the purpose. It had not been under previous cultivation for many years, and a portion of it, as is seen in the report of the director, suffered severely from various causes. The special plots which were cultivated in the high-grade seeds gave fairly good results, as will be seen farther on, and the beets produced were of good size, fair shape, and fine quality.

At the Iowa station fairly good seasonal conditions prevailed, and the character of the beets produced on the specially prepared plots was satisfactory.

At the Kentucky station the beets obtained a good start, and grew well for the greater part of the season. They were slightly retarded by dry weather at one period of their growth, but on the whole reached a fair stage of maturity without untoward accidents. The beets which were harvested in September and October showed a higher content of sugar than those that were left later in the ground, and this is probably due to the second growth, which was produced by the warm climate of that locality. The sugar content was exceedingly low, and the data secured from the station show conclusively that Kentucky is not in the list of possibilities as a sugar-producing State in so far as beets are concerned.

The data from Tennessee are extremely meager, and no definite conclusions can be drawn from those at hand.

In the study of the data received, it will be convenient to begin with the most southern station, namely, Tennessee, and then continue with the Kentucky, Indiana, Iowa, Wisconsin, and New York stations in the order named.

Tennessee.

The results obtained at the Tennessee station were extremely unsatisfactory. On account of the poor quality of the beets, only one sample was sent for analysis, which was harvested on the 25th of September. These beets were so small as to hardly deserve the name, and no attempt

was made to determine the purity of the juice. It is evident, from an inspection of the table which follows, that there was nothing in the result of the experiment to justify a further examination of the beets produced.

The cause of failure in Tennessee has been reported by the secretary of the station in the letter given below, and therefore no further explanation need be made here of the failure to attain even fairly satisfactory results.

THE AGRICULTURAL EXPERIMENT STATION
OF THE UNIVERSITY OF TENNESSEE,
Knoxville, February 15, 1897.

DEAR SIR: A reference to plat sent you May 26, 1897, will explain the following:

Sugar beets grown from seed sown May 19, 20, 1897, were lifted when properly ripe, tops removed and put into separate piles on the ground close by, and covered with earth. In this condition the various lots remained until taken up to be weighed on 13th of this month. Roots found in good order, and are now being fed to our cows. The weights of the several lots were as follows:

Plat.	Variety and from whence received.	Area.	Weight.
		Sq. ft.	*Pounds.*
Subdivision N	Vilmorin's Improved White, from P. Henderson & Co., New York.	880	175
Subdivision J	Kleinwanzlebener Elite, Dippe Brothers, from Department.	589	54
Subdivision D	Vilmorin's, la plus rich, from Department	1,568	280
Subdivision C	High grade Kleinwanzlebener, from Department	1,642	369
Subdivision A	Memte Ober Wurst, Quedlinburg, Dippe Brothers, from Department.	448	64.5
Subdivision B (2 rows)	Original Kleinwanzelebener (Holland), from Department.	64	16.5
Subdivision B (3 rows)	Vilmorin's Improved (Schuyler, Nebr.), from Department.	96	12
Subdivision B (9 rows)	Demesmay, from Department	288	56
Subdivision E (triangle)	White Improved Imperial Elite (Grashoff), from Department.	224	124.5
		5,796	1,115.5

8,715 pounds per acre.

A miserably poor yield.—Soil prepared in best manner; germination good; when first leaves were formed an excellent stand. A few days after an incursion of flea beetles destroyed almost every plant in an irregular strip across the whole plat; this was done between the hours of 11 a. m. and 3 p. m., in one day. Cultivation was well and thoroughly done, but the planting was much too late. A plat of Vilmorin's Improved White grown near the farm building, the seed for which was planted April 1, gave us a very heavy yield. These were planted for table use and for stock feeding, and were purposely grown to make feed stuff, not for sugar.

Very respectfully, yours,

CHAS. F. VANDERFORD,
Secretary.

Dr. H. W. WILEY,
Chief Division of Chemistry, U. S. Department of Agriculture,
Washington, D. C.

The details of the analytical data are found in the accompanying table of data.

KENTUCKY.

Special care was taken by the director of the station at Lexington to secure satisfactory results. During the early part of the season the beets grew exceptionally well and presented a fine appearance. The

quantity produced was fairly good, although the beets were somewhat irregular in size, some of them being quite large and others quite small. The sugar content of the beets and the purity of the juice were both extremely low. The first series of samples was analyzed on the 28th of September, and a second set of samples from two of the varieties was analyzed at a later date. The original Kleinwanzlebener (Holland) seed was represented by thirty-seven beets in this second sample, the average size of which was small and the sugar content medium. The White Improved Imperial Elite was represented in the second sample by forty-eight beets, also extremely small, and with a low content of sugar. The final harvest of the beets resulted in securing three barrels of beets of fine size and shape, but when these beets were perforated for analysis it was found that the content of sugar was low, falling, in some cases, as low as 2 per cent. The sugar content in general was so small that it was not deemed worth while to report it, as the beets were utterly worthless for seed production. The depressing influence of climate on the character of the beets is illustrated in a most striking manner by a comparison of the results obtained from beets grown in Kentucky and in Geneva, N. Y., from the same seeds, and under as nearly as possible identical conditions of culture.

Indiana.

The unfortunate seasonal conditions which obtained at the experiment station at Lafayette have already been mentioned. The result of the prolonged drought during the growing season was a diminution of the weight of the beets to such an extent that for practical purposes they were useless. For this reason the data obtained are of little value. On account of the inferior character of the beets, no attempt was made to select any of them for mothers for the subsequent production of seed. The analytical data connected with the special plot work in Indiana are found in the tables following.

Iowa.

Only one set of samples was received from the plots grown in Iowa, the sample of the Demesmay having been harvested on the 25th of September and all the other samples on the 13th of November. The average size of the beets received was small, the percentage of sugar only fair, and the purity not up to the minimum standard. The seasonal influences at Ames were therefore evidently inferior in sugar-producing qualities to those which obtained in New York. The final harvest of beets was not forwarded to the Department for the purpose of selecting mothers by reason of a misunderstanding whereby the different varieties were mixed in such a way that the separation of them was impracticable. A general statement in regard to the special

plot work done at Ames is contained in the following letter from Director Curtiss:

AMES, IOWA, *January 25, 1898.*

DEAR SIR: Replying to your inquiry concerning the test of high-grade sugar-beet seed furnished by your Department, will say that we have forwarded you two samples of the Vilmorin's Elite from the plats grown according to your instructions, and have lately had your report of the last sample. The beets from these plats were analyzed by Dr. Weems, of our chemistry section, with the following results:

Variety.	Sugar.	Purity coefficient
	Per cent.	
Vilmorin's Élite	16.07	84.30
Demesmay	14.30	78.38
Improved Imperial Élite	13.31	76.14
Kleinwanzlebener	16.91	90.76

These samples and the one forwarded to you gave substantially the same results and were harvested November 11. The first sample sent you was taken earlier and was probably immature. The past season was quite backward here, and the beet crop correspondingly late in maturing. Owing to a change in our field-experiment department during the past year, the beets from these plats were, through a misunderstanding, thrown together instead of being kept separate after the analyses were made, and we will not be able to distinguish between varieties in testing these beets and carrying on future work along this line. We very much regret that this mistake has occurred, as we would like to continue the work of developing high-grade beets for seed production. We will be glad to cooperate with you again during the coming season if you can furnish us more seed.

Very truly, yours,

C. F. CURTISS.

Dr. H. W. WILEY,
Washington, D. C.

The analytical data derived from the analyses of beets sent from the Iowa station to this laboratory are of little value. Only one set of samples was received, namely, of the Demesmay variety, harvested on the 25th of September, and of the three varieties harvested on the 13th of November. With the exception of the Vilmorin Élite, which was received on the 22d of November, the analytical data are not satisfactory. In the case of the variety just mentioned the sugar content and the purity were satisfactory, but the beets were very much under size. It is evident that the data obtained in the past season do not fairly represent the capabilities of Iowa, either for the production of good commercial beets or for the growth of beets for seed-producing purposes. The analytical data obtained on analysis of the samples received at the Department are found in the table given farther on.

WISCONSIN.

Complete details of experiments with high-grade beet seeds, grown under the auspices of the Department of Agriculture, are found in the

Wisconsin report, contained in Bulletin No. 64 of that station. These details are so valuable as to warrant their reproduction in full:

EXPERIMENTS WITH HIGH-GRADE SUGAR-BEET SEED.

These experiments were, as already stated, conducted under the auspices of the United States Department of Agriculture. In a letter received in the early part of April last, the chief chemist of the Department, Dr. H. W. Wiley, requested this station to cooperate with the Department in growing a number of varieties of beets from high-grade seed furnished by them, giving the beets the best of conditions in respect to subsoiling, preparation of the seed bed, and cultivation. Some of the kinds of seed sent were produced by the highest possible scientific culture from specially analyzed beets, which were stated to average 19 per cent of sugar. According to the directions received, the Government plat was surrounded on all sides by our regular beet field and was located in the southeastern quarter of our main field. The different kinds of seed received and planted by hand on May 22 were as follows:

Plat A.—Dippe Brothers, Vilmorin Élite R I, from Dippe Brothers, Quedlinburg, Germany.

Plat B.—1. Original Kleinwanzlebener, grown by Kühn, Naarden, Holland. 2. Vilmorin Improved, grown at United States Sugar Beet Station at Schuyler, Nebr. 3. Demesmay sugar-beet seed, grown by F. Demesmay, Cysoing (Nord), France.

Plat C.—High-grade Commercial Kleinwanzlebener.

Plat D.—High-grade Commercial Vilmorin's Improved "La Plus Riche."

White Improved Imperial Élite, grown by Martin Grashoff, Quedlinburg, Germany.

Dippe Brothers, Kleinwanzlebener Élite W I, from Dippe Bros., Quedlinburg, Germany.

The plats were arranged, as suggested by Dr. Wiley, in the following manner: Plats A and B, each 21 by 24 feet, were placed in the middle and were surrounded by a border, CC, 67 feet long and 9½ feet wide; the plats D^1 and D^2 were placed at the east and west ends of the C plat, being 21 by 40 feet. South and north of the whole plat three rows were run 110 feet long, in which were planted the varieties given in the preceding statement, White Imperial being planted in the south three rows, and Kleinwanzlebener Élite in the north three rows. The rows were 18 inches apart. The effort was to have one good vigorous beet plant at about every 9 inches in the row after thinning.

The germinations of the seed planted in this experiment, as well as of that planted in our other trials, were determined by Professor Goff, and are given on pages 300–301 of our Fourteenth Annual Report. It will be seen that the germinative power of the different kinds of seed was very good, with the possible exception of the Schuyler, Nebr., seed, which was old, and the Dippe Brothers' Vilmorin Élite seed. The average germination of the seed was 167 per cent, ranging from 115 to 231 per cent, the latter result being obtained with the White Improved Imperial Élite.

The first samples of the beets raised on the Government plat were taken September 20; another sample was taken September 27, and after that time every fourteen days until the beets were harvested, on November 5. In sampling the beets four beets were dug of each kind. Two of these were forwarded to Washington, D. C., to the Department of Agriculture, and the other two retained for analysis in our own laboratory.

The results of the analyses made by the writer are given in the following table. The C^1 samples were taken south of the A and B plats and the C^2 samples north of these plats. In the same manner the D^1 and D^2 samples were taken from the plats east and west, respectively, of the central plats.

Main field, Government plat.

Variety.	Date of sampling.	Per cent root of whole plant.	Weight of beets.	Analysis of juice.		
				Specific gravity.	Sugar.	Purity coefficient
			Pounds.		*Per cent.*	
Imperial Elite	Sept. 20	70	0.21	1.0755	14.44	79.1
	Sept. 27	70	.40	1.0934	17.92	80.5
	Oct. 11	78	.40	1.0834	17.04	85.0
	Oct. 25	80	.58	1.0858	16.55	79.4
	Nov. 5	.....	.83	1.0740	14.35	80.1
Average		.....	.48	.....	16.02	80.8
Vilmorin La Plus Riche, D_1	Sept. 20	73	.34	1.0882	16.96	80.4
	Sept. 27	73	.80	1.0923	17.58	79.9
	Oct. 11	72	.98	1.0895	17.93	83.8
	Oct. 25	82	.95	1.0860	16.40	79.5
	Nov. 5	.....	1.20	1.0882	16.53	78.3
Average		.....	.85	.....	17.08	80.4
High-grade Kleinwanzlebener, C_1	Sept. 20	73	.37	1.0825	16.45	83.0
	Sept. 27	70	.55	1.0898	17.21	80.0
	Oct. 11	59	.50	1.0870	16.15	77.5
	Oct. 25	78	.50	1.0810	14.35	73.6
	Nov. 5	.....	1.13	1.0845	16.90	83.5
Average		.....	.61	.....	16.21	79.5
Vilmorin Improved, Nebr., B	Sept. 20	70	.75	1.0725	15.06	85.7
	Sept. 27	76	.45	1.0810	16.70	85.7
	Oct. 11	80	1.13	1.0848	17.01	83.6
	Oct. 25	91	.75	1.0857	15.86	77.2
	Nov. 5	.....	.71	1.0800	15.71	81.5
Average		.....	.76	.....	16.07	82.7
Original Kleinwanzlebener, Holland, B	Sept. 20	68	.45	1.0860	16.63	80.7
	Sept. 27	67	.20	1.0946	18.57	82.4
	Oct. 11	73	.40	1.0935	17.95	80.6
	Oct. 25	73	.30	1.0980	17.34	74.5
	Nov. 5	.....	.35	1.0920	18.65	81.8
Average		.....	.37	.....	17.83	80.0
Dippe's Kleinwanzlebener	Sept. 20	64	.70	1.0695	14.57	86.3
	Sept 27	68	.90	1.0836	17.11	85.2
	Oct. 11	71	.93	1.0917	18.17	83.0
	Oct. 25	71	.50	1.1070	21.45	85.2
	Nov. 5	.....	.95	1.0812	16.42	84.0
Average		.....	.80	.....	17.54	84.7
Vilmorin's La Plus Riche, D_2	Sept. 20	67	1.03	1.0735	16.13	90.6
	Sept. 27	72	1.15	1.0800	16.90	83.6
	Oct. 11	73	1.23	1.0868	17.56	84.4
	Oct. 25	78	1.35	1.0917	18.88	86.3
	Nov. 5	.....	.....	.....	.....	.....
Average		.....	1.19	.....	17.37	86.1
High-grade Kleinwanzlebener, C_2	Sept. 20	72	1.05	1.0850	17.94	87.9
	Sept. 27	65	.70	1.0842	16.70	82.6
	Oct. 11	75	.70	1.0885	17.57	83.0
	Oct. 25	82	1.30	1.0940	19.18	85.7
	Nov. 5	.....	.....	.....	.....	.....
Average		.....	.94	.....	17.85	84.8
Demesmay Improved, B	Sept. 20	76	.80	1.0655	13.23	82.8
	Sept. 27	81	.93	1.0695	13.49	79.8
	Oct. 11	78	1.10	1.0678	12.85	77.9
	Oct. 25	89	.85	1.0798	15.95	83.0
	Nov. 5	.....	.93	1.0690	13.66	81.4
Average		.....	.92	.....	13.84	81.0
Dippe Vilmorin, A	Sept. 20	63	.62	1.0790	16.05	84.3
	Sept. 27	73	1.00	1.0852	16.86	82.5
	Oct. 11	73	1.10	1.0895	17.49	81.7
	Oct. 25	82	1.03	1.0920	18.34	83.6
	Nov. 5	.....	.75	1.0827	16.91	85.1
Average		.....	.90	.....	17.13	83.4

We notice that the per cent of sugar in the juice but rarely came over 18 in case of the different varieties, the average figures ranging from 13.84 per cent (Demesmay) to 17.85 per cent (High-grade Commercial Kleinwanzlebener, C_2); the purity of the beet juice was good, viz, lowest 79.5 (High-grade Commercial Kleinwanzlebener, C_1), highest 86.1 (Vilmorin La Plus Riche, D_2).

The average results of the analyses of these beets obtained by the Department of Agriculture and in this laboratory are given below:

Determinations made by—	Number of analyses.	Polariscope method.	Alc. extraction method.	Purity coefficient.
United States Department of Agriculture	38 (31*)	16.27	.....	84.7
Wisconsin Experiment Station	38 (31*)	16.09	15.13	82.0

* Number of determinations of purity of juice.

While the agreement is as good as could be expected between the results obtained by the polariscope method, the purity coefficient differs rather more than allowable in duplicate samples. The two sets of analyses differ in this way, that the Department of Agriculture samples were always analyzed at least several days after our analyses were made, since the latter were always finished within twenty-four hours from the time of sampling. In single instances, variations occurred between the Department of Agriculture and our analyses of 3 per cent of sugar in the juice and of over 7 per cent purity, owing to differences in the stage of maturity of the beets analyzed; it is evident that no absolutely correct idea of the sugar content of the beets in a certain plat or field can be obtained by pulling and analyzing two single beet roots, even if these do appear to be at about average stage of maturity.

The yield of beets from the plat, obtained at harvesting, November 5, and the calculated yield of beets and of sugar per acre, are shown in the following table:

Yield of beets and of sugar, Government plat.

Name of variety.	Yield of beets.		Average weight of beets.	Sugar in the beet.	Sugar per acre.
	From plat.	Per acre.			
	Pounds.	*Pounds.*	*Pounds.*	*Per cent.*	*Pounds.*
Imperial Elite	272.3	24,210	0.45	13.63	3,300
Vilmorin La Plus Riche	1,167.3	28,290	.64	15.70	4,441
High-grade Commercial Kleinwanzlebener	1,170.0	30,660	.56	16.05	4,920
Dippe Brothers Kleinwanzlebener Elite	311.7	34,380	.66	15.60	4,995
Dippe Brothers Vilmorin Elite	336.6	29,090	.58	16.06	4,672
Demesmay	234.4	31,520	.61	12.98	4,092
Vilmorin, Schuyler, Nebr	76.7	30,940	.59	14.92	4,616
Original Kleinwanzlebener, Holland	26.0	15,730	.27	17.72	2,788
Averages, etc	3,595.0	28,103	.....	15.04	4,228

The average yield of beets per acre obtained was over 14 tons, or about 5 tons more than the yield obtained from either half of the main field. The average calculated yield of sugar per acre was 4,228 pounds, the lowest yield being obtained in case of Original Kleinwanzlebener, Holland (2,788 pounds), which variety plainly suffered most from the drought, and the highest in case of Dippe's Kleinwanzlebener Elite (4,995 pounds).

ANALYSES MADE AT THE LABORATORY OF THE DEPARTMENT OF AGRICULTURE.

Samples of beets from the high-grade plots were sent from time to time to the laboratory of the Department of Agriculture for analysis, and finally all the remaining beets of proper size were forwarded for

examination. The following table contains the analyses of the samples received from the various stations of the three separate harvests of beets, ranging from the last of September to the last of October, together with the analyses of all the samples of the high-grade beets harvested in the middle of November:

Table showing analyses of beets of high grade from experiment stations of Tennessee, Kentucky, Indiana, Iowa, Wisconsin, and New York.

KNOX COUNTY, TENN.

[Experiment Station, Knoxville.]

Serial No.	Variety.	Time of planting.	Time of harvesting.	Date received.	Number of beets.	Average weight.	Sugar in the beets.	Purity coefficient.
		1897.	1897.	1897.		*Ounces.*	*Per ct.*	
200	White Improved Imperial Elite	May 24	Sept. 25	Sept. 27	2	4	11.5	.....
201	Kleinwanzlebener Elite	....do ...	....do ...	....do ...	2	7	10.7	.....
203	Original Kleinwanzlebener (Dippe Brothers)	May 18	....do ...	....do ...	2	3	12.5	.....
204	Original Kleinwanzlebener (Holland)	....do ...	....do ...	....do ...	4	1	12.5	.....
206	High grade Kleinwanzlebener	....do ...	....do ...	....do ...	2	6	12.0	.....
202	Vilmorin's "La Plus Riche"	....do ...	....do ...	....do ...	2	7	10.6	.....
205	Vilmorin's Improved	....do ...	....do ...	....do ...	5	1	13.2	.....
207	Demesmay	....do ...	....do ...	....do ...	3	1	13.5	.....

FAYETTE COUNTY, KY.

[Experiment Station, Lexington.]

		1897.	1897.	1897.				
285	Original Kleinwanzlebener (Holland)	.....	Sept. 27	Sept. 29	.....	21	13.3	72.5
834–870	.....do	.....	Oct. 14	Oct. 18	37	7	15.8	.....
286	Vilmorin's Improved (Schuyler, Nebr.)	.....	Sept. 27	Sept. 29	.....	19	10.9	68.5
287	Demesmay	.....	....do ..	....do ...	.....	18	9.5	65.0
293	White Improved Imperial Elite	.....	....do ..	....do ...	.....	17	10.9	68.1
785–832	.....do	.....	Oct. 14	.....	48	7	11.1	.....

TIPPECANOE COUNTY, IND.

[Experiment Station, Lafayette.]

		1897.	1897.	1897.				
169	Original Kleinwanzlebener (Holland)	May 5	Sept. 24	Sept. 27	2	4	16.5	.....
436	.....do	....do ...	Oct. 8	Oct. 10	2	5	14.3	.....
2203	.....do	....do ...	Nov. 22	Nov. 24	5	6	19.1	84.4
171	Kleinwanzlebener Elite (Dippe Brothers)	May 19	Sept. 24	Sept. 26	2	3	14.4	.....
448	.....do	....do ...	Oct. 8	Oct. 10	2	4	14.7	.....
2202	.....do	....do ...	Nov. 22	Nov. 24	6	9	18.5	83.6
172	Demesmay	May 5	Sept. 24	Sept. 26	2	5	12.6	.....
449	.....do	....do ...	Oct. 8	Oct. 10	2	8	12.5	.....
2204	.....do	....do ...	Nov. 22	Nov. 24	14	9	14.3	80.6
178	Vilmorin's Improved Elite (Dippe Brothers)	May 19	Sept. 24	Sept. 26	2	4	13.9	.....
447	.....do	....do ...	Oct. 8	Oct. 10	2	4	14.6	.....
2206	.....do	....do ...	Nov. 22	Nov. 24	5	7	16.5	80.1
180	Vilmorin's Improved (Schuyler, Nebr.)	May 5	Sept. 24	Sept. 26	2	6	14.5	.....
2205	.....do	....do ...	Nov. 22	Nov. 24	10	7	15.4	81.3
430	Vilmorin's Improved	....do ...	Oct. 8	Oct. 10	2	6	16.1	.....

Table showing analyses of beets of high grade from experiment stations of Tennessee, Kentucky, Indiana, Iowa, Wisconsin, and New York—Continued.

STORY COUNTY, IOWA.

[Experiment Station, Ames.]

Serial No.	Variety.	Time of planting.	Time of harvesting.	Date received.	Number of beets.	Average weight.	Sugar in the beets.	Purity coefficient.
		1897.	1897.	1897.		*Ounces.*	*Per ct.*	
249	Demesmay	May 29	Sept. 25	Sept. 28	3	11	13.9	.....
2078	White Improved Imperial Elite	....do ...	Nov. 13	Nov. 22	2	13	16.7	79.1
2088	Vilmorin's Improved	....do ...	....do ...	....do ...	2	19	13.0	72.5
2099	Vilmorin's Elite	....do ...	....do ...	....do ...	2	12	17.3	82.6
2100	Original Kleinwanzlebener	....do ...	....do ...	....do ...	2	20	12.8	72.4

DANE COUNTY, WIS.

[Experiment Station, Madison.]

		1897.	1897.	1897.				
217	Dippe's Kleinwanzlebener	May 22	.....	Sept. 29	2	10	15.0	80.5
882	.....do	....do ...	.....	Oct. 12	2	11	18.5	87.3
1465	.....do	....do ...	.....	Oct. 27	2	9	19.5	.....
1912	.....do	....do ...	Nov. 3	Nov. 17	12	16	15.3	83.1
	Averages*	.....	.....	.....	.....	14	15.9	83.3
222	Original Kleinwanzlebener (Holland)	May 22	.....	Sept. 29	2	5	15.4	.....
881	.....do	....do ...	.....	Oct. 12	2	8	18.9	87.2
1469	.....do	....do ...	.....	Oct. 27	2	7	18.9	.....
1913	.....do	....do ...	Nov. 2	Nov. 17	11	6	18.7	80.7
	Averages*	.....	.....	.....	.....	6	18.4	82.0
225	Kleinwanzlebener	May 22	.....	Sept. 29	2	13	14.6	85.0
877	.....do	....do ...	.....	Oct. 12	2	9	16.3	82.2
1468	.....do	....do ...	.....	Oct. 27	2	13	17.3	84.1
226	.....do	....do ...	.....	Sept. 29	2	9	13.8	86.3
878	.....do	....do ...	.....	Oct. 12	2	6	15.5	86.2
1464	.....do	....do ...	.....	Oct. 27	2	6	18.5	.....
1918	.....do	....do ...	Nov. 3	Nov. 17	188	15	17.3	85.1
	Averages*	.....	.....	.....	.....	14.7	17.2	85.1
218	White Improved Imperial Elite	May 22	.....	Sept. 29	2	9	14.0	86.0
876	.....do	....do ...	.....	Oct. 12	2	8	17.1	.....
1463	.....do	....do ...	.....	Oct. 27	2	5	18.3	.....
1911	.....do	....do ...	Nov. 3	Nov. 17	12	15	15.4	83.2
	Averages*	.....	.....	.....	.....	12.4	15.5	83.5
219	Dippe's Vilmorin Elite	May 22	.....	Sept. 29	2	14	14.3	84.3
880	.....do	....do ...	.....	Oct. 12	2	10	18.3	87.2
1466	.....do	....do ...	.....	Oct. 27	2	16	18.5	86.9
1917	.....do	....do ...	Nov. 2	Nov. 17	115	14	17.7	86.7
	Averages*	.....	.....	.....	.....	14.0	17.7	86.7
221	Vilmorin's Improved Schuyler, seed	May 22	.....	Sept. 29	2	16	13.6	82.6
879	.....do	....do ...	.....	Oct. 12	2	15	16.8	85.0
1461	.....do	....do ...	.....	Oct. 27	2	12	16.2	82.1
1916	.....do	....do ...	Nov. 2	Nov. 17	24	12	15.6	82.5
	Averages*	.....	.....	.....	.....	12.4	15.6	82.7

* In figuring the averages, each analysis is valued in proportion to the weight of the sample.

Table showing analyses of beets of high grade from experiment stations of Tennessee, Kentucky, Indiana, Iowa, Wisconsin, and New York—Continued.

DANE COUNTY, WIS.—Continued.

Serial No.	Variety.	Time of planting.	Time of harvesting.	Date received.	Number of beets.	Average weight.	Sugar in the beets.	Purity coefficient.
		1897.	1897.	1897.		*Ounces.*	*Per ct.*	
223	Vilmorin's "La Plus Riche"	May 22	.....	Sept. 29	2	18	14.9	83.4
871	.....do	....do	.....	Oct. 12	2	16	17.9	88.2
1462	.....do	....do	.....	Oct. 27	2	12	17.6	85.2
224	.....do	....do	.....	Sept. 29	2	13	14.3	86.2
875	.....do	....do	.....	Oct. 12	2	8	19.2	.....
1467	.....do	....do	.....	Oct. 27	2	10	19.0	85.4
1915	.....do	....do	Nov. 3	Nov. 17	236	15	17.7	86.7
	Averages†	.....	.....	.....	.....	15	17.7	86.8
220	Demesmay	May 22	.....	Sept. 29	2	12	13.4	84.8
1470	.....do	....do	.....	Oct. 12	2	12	15.0	83.5
1914	.....do	....do	Nov. 2	Nov. 17	91	13	13.6	81.0
	Averages†	.....	.....	.....	.....	13	13.6	81.1

ONTARIO COUNTY, N. Y.

[Experiment station, Geneva.]

227	White Improved Imperial Elite	1897. May 19	1897. Sept. 27	1897. Sept. 28	4	14	12.6	80.6
1409	.....do	....do	Oct. 14	Oct. 15	4	16	14.8	82.0
	.....do	....do	Oct. 29 / Oct. 30	.....	174	18	15.3	(*)
	Averages†	.....	.....	.....	.....	18	15.2	81.3
228	Vilmorin's "La Plus Riche"	May 19	Sept. 27	Sept. 28	4	20	15.1	85.5
231	.....do	....do	....do	....do	4	17	15.6	87.2
1403	.....do	....do	Oct. 14	Oct. 15	4	16	16.8	84.2
1410	.....do	....do	....do	....do	4	16	16.6	85.7
	.... do	....do	Oct. 29 / Oct. 30	.....	207	20	18.3	(*)
	Averages†	.....	.....	.....	.....	20	18.1	85.6
229	Vilmorin's Improved (Schuyler, Nebr.)	May 15	Sept. 27	Sept. 28	5	20	14.2	84.2
1406	.....do	....do	Oct. 14	Oct. 15	4	16	15.2	87.8
	.....do	....do	Oct. 29 / Oct. 30	.....	32	18	15.7	(*)
	Averages†	.....	.....	.....	.....	18	15.5	85.6
234	Vilmorin's Improved	May 19	Sept. 27	Sept. 28	4	15	13.6	82.2
1404	.....do	....do	Oct. 14	Oct. 15	4	15	14.6	81.4
	Averages†	.....	.....	.....	.....	15	14.1	81.8
230	Demesmay	May 19	Sept. 27	Sept. 28	4	18	13.3	82.8
1401	.....do	....do	Oct. 14	Oct. 15	4	16	12.3	79.2
	.....do	....do	Oct. 29 / Oct. 30	.....	107	18	15.9	(*)
	Averages†	.....	.....	.....	.....	18	15.7	81.1
232	Vilmorin's Improved Elite (Dippe Brothers)	May 19	Sept. 27	Sept. 28	4	19	15.2	86.0
1407	.....do	....do	Oct. 14	Oct. 15	4	16	16.7	84.9
	.....do	....do	Oct. 29 / Oct. 30	.....	64	19	18.1	(*)
	Averages†	.....	.....	.....	.....	19	17.9	85.5

*Not included in averaging the purity coefficients.

†In figuring the averages, each analysis is valued in proportion to the weight of the sample it represents.

Table showing analyses of beets of high grade from experiment stations of Tennessee, Kentucky, Indiana, Iowa, Wisconsin, and New York—Continued.

ONTARIO COUNTY, N. Y.—Continued.

Serial No.	Variety.	Time of planting.	Time of harvesting.	Date received.	Number of beets.	Average weight.	Sugar in the beets	Purity coefficient.
		1897.	1897.	1897.		*Ounces.*	*Per ct.*	
233	High-grade Commercial Kleinwanzlebener	May 19	Sept. 27	Sept. 28	4	20	15.1	86.4
1402	do	do	Oct. 14	Oct. 15	4	15	15.2	83.2
	do	do	Oct. 29 Oct. 30		224	18	17.8	(*)
	Averages†					18	17.7	85.0
235	Original Kleinwanzlebener (Holland)	May 19	Sept. 27	Sept. 28	4	18	16.2	86.7
1405	do	do	Oct. 14	Oct. 15	4	13	16.4	84.7
	do	do			7	18	19.2	(*)
	Averages†					17	17.7	85.8
1408	Kleinwanzlebener Elite (Dippe Brothers)	May 19	Oct. 14	Oct. 15	4	16	17.3	84.6
	do	do	Oct. 29 Oct. 30		211	20	18.7	
	Averages					20	18.7	

* Not included in averaging the purity coefficients.
† In figuring the averages, each analysis is valued in proportion to the weight of the sample it represents.

Discussion of above data.—No further discussion of the analytical data contained in the above table is necessary, except in the case of the samples received from Wisconsin and New York. These samples were exceptionally fine. By an unfortunate misunderstanding all the beets received from Wisconsin were reduced to pulp for the purpose of getting an average sample for analysis. The selection for mother beets was, therefore, confined to the samples from New York.

WISCONSIN.

Almost uniformly good results were obtained in these experiments. The Original Kleinwanzlebener (Holland) seed produced beets, however, too small for all practical purposes, although the sugar content and purity were high. The largest beets and those of the highest purity were produced by the Vilmorin La Plus Riche seed. The Demesmay seed which were used were only the commercial article, and were not grown from specially analyzed mothers. It is not surprising, therefore, to see that they produced a crop which was the poorest of all in sugar content.

The particular analyses of the most importance are those which were made on the beets received November 17, and harvested on the 3d of November. These practically represent the beets at their full maturity, as it is not probable that they would improve in quality in the climate of Madison after the 1st of November. The analyses also represent the greatest number of beets, and therefore are the most reliable. The largest number of beets of proper size and shape were produced by the Vilmorin La Plus Riche seed, and the

smallest by the Original Kleinwanzlebener. The beets grown from the Schuyler seed are of particular interest because they represent the link of union between the experiments which were discontinued by the Department in 1893 and reinaugurated in 1897. The average size of the beets produced by the Schuyler seed is somewhat small, but the content of sugar and the purity are satisfactory. Upon the whole, the effect of high-grade seed and high culture are most distinctly marked. It is only necessary to compare the results obtained in the experiments with these high-grade seeds with those secured in the State at large to show the possibilities of beet production in Wisconsin. With such data before the investigator, it is evident that he must be convinced of the fact that it is possible, with proper conditions of seed and culture, to produce a grade of beets of the highest quality in Wisconsin.

New York.

Most satisfactory results were obtained from the experimental work in the State of New York at Geneva. Two sets of samples were received from the station, representing intervals of about two weeks in harvesting, the first set of samples having been harvested on the 27th of September and the second on the 14th of October. It will be noticed that a marked improvement was secured by postponing the harvest for two weeks, showing that as a rule it is not to be expected that the season for manufacturing in New York should begin before the middle of October. The above table includes also the final harvest, which was made much later in the season, viz, October 29–30, and shows even a greater improvement. The beets from the final harvest were all sent to Washington, and were carefully selected for seed production. The data obtained in this selection are given as the third in the series of analyses. The samples which were grown at the New York station were from seeds of two different qualities: First, commercial seeds, as represented by the Demesmay White Imperial and high-grade commercial Kleinwanzlebener; and, second, seeds grown directly from high-grade mothers, represented by the Vilmorin La Plus Riche, the Vilmorin Improved (Schuyler), and the Original Kleinwanzlebener. The average size of the beets selected for analysis was not quite 20 ounces; the sugar content in most cases was high, and the purity extremely satisfactory. After leaving the beets unharvested until the end of October they were found to have increased their content of sugar very markedly, as will be shown in the table of analyses for the selection of mothers. The encouraging data obtained at the New York station suggests that if the Department should reestablish its experiment stations for the production of high-grade seeds one of them should be placed in this locality.

In the analysis of the beets to be selected as mothers for producing seeds no attempt was made to determine the coefficient of purity, as the amount of pulp removed was only sufficient to determine the

percentage of sugar directly therein. It is evident, however, that the purity coefficients of all the different varieties would not have been diminished by perfect maturity, so that they may be regarded as fully equal to the average in each case. In fact, it would be fair to assume that the averages of the final harvest of the most mature beets were slightly above those taken for the average of the three analytical periods of the season. In the discussion of the data obtained by the analysis it must be remembered that the averages in all cases are made upon the total weight of the material entering into the analysis. Not only is this true of each individual sample, but also of the average analyses of the samples. It is evident that this is the one exact method of obtaining average results, and it is only the averages obtained by such a method that have a convincing value.

DATA OF EACH VARIETY.

The White Improved Imperial Élite, grown from commercial seeds gave beets of fair commercial quality. An average weight of 18 ounces, with a content of 15.2 per cent of sugar in the beets and a coefficient of purity of 81.3, would insure a large yield in a well-built and well-operated factory. From the complete harvest, 174 beets were found of the required size, shape, and sugar content to warrant saving for the production of seed. It is evident, however, that this seed would be only of a medium grade commercial quality, and not suited to the improvement of the beet.

Vilmorin La Plus Riche.—This plot gave excellent results throughout. The average size of the beets was the largest of any of the plots grown. The purity coefficients were exceptionally high, and the sugar contents most satisfactory. Two hundred and seven beets grown on this plot, having an average weight of 20 ounces and a mean content of sugar of 18.3 per cent, were selected for seed production. It is evident that the coefficient of purity of this selection must have been at least 86. These mothers will therefore produce seeds of the highest quality, which can subsequently be planted, growing beets for the production of seeds of exceptional properties.

Vilmorin Improved, Schuyler Seed.—This variety is chiefly of interest now because it represents the continuation of the work in seed production which was discontinued four years ago. The seeds evidently have lost in vitality by their long keeping, and the product, therefore, is not as satisfactory as could have been desired. The average sugar content is not exceptionally high, but the purity is excellent. The beets produced from these seeds in another year will doubtless develop some exceptionally high-grade mothers, and thus the strain will be continued. This plot represents the sole surviving result of the three years' experiments at Schuyler, commenced in 1890. Thirty-two beets, with an average weight of 18 ounces and an average content of sugar of 15.7 per cent were put aside for seed production. It is seen, from an

inspection of the table, that the coefficient of purity of this lot was 87 or more. It therefore represents the highest grade of purity of any of the lots.

Vilmorin Improved.—This is a commercial seed, used for planting around the central plots, and has produced a crop of only fair commercial value.

Demesmay.—This is also a commercial seed, obtained directly from the growers in the north of France, and, as will be seen from an inspection of the table, produced a crop of excellent commercial value.

Vilmorin Improved Élite, grown by Dippe Brothers.—This seed represents the improvement in the strain of the Vilmorin beet when cultivated according to the highest scientific principles in Germany. Sixty-four beets grown on this plot, having an average weight of 19 ounces, were selected for mothers. The mean content of sugar in these beets was 18.1. It is evident, also, that the purity was at least 86 per cent. This harvest, therefore, represents a very high grade quality of mothers for continuing the improvement.

High-grade Commercial Kleinwanzlebener.—This variety of seed represents the highest grade of commercial seeds offered to the market. The results of culture show that the tendency of this seed to produce rich beets is extremely well marked. Two hundred and twenty-four beets grown on this plot, with an average weight of 18 ounces, were selected as mothers. The mean content of sugar in these beets was 17.8 per cent, and the purity, as seen by the table, is evidently high. These high-grade commercial seeds, therefore, produce a strain of beets almost as valuable for sugar production as the specially high grade seeds from analyzed mothers.

Original Kleinwanzlebener (Holland.)—This variety of seed represents the Kleinwanzlebener type as cultivated to the highest degree in Holland. The tendency in that country seems to be to the production of a beet of small size and exceptionally high sugar content. Only a few of these high-grade seeds were planted, and this, together with their small size, accounts for the fact that only seven were selected. The mean weight of the seven was 18 ounces, the mean content of sugar therein 19.2, and the coefficient of purity evidently 86 or over. This variety produced the highest content of sugar of any cultivated, but on account of the small size is less to be recommended for general cultivation in this country than some of the other varieties.

Kleinwanzlebener Elite.—This variety represents the specially-selected seeds grown by Dippe Brothers, at Quedlinburg. The beets grow to a fine size, are of good shape, and have excellent qualities to recommend them to the manufacturer. Two hundred and eleven of these beets, having an average weight of 20 ounces, were selected as mothers. The mean content of sugar in these beets was 18.7 per cent, and the coefficient of purity, as will be seen by the table, good.

CLASSIFICATION OF THE BEETS OF EACH VARIETY.

It will be interesting to study the distribution of the beets of each variety according to sugar content. This can be done by means of the following table:

Variety.	Number of beets having contents of sugar from—				Maximum polarizations of individual beets.	Minimum polarizations of individual beets.
	15 to 16 per cent.	16 to 17 per cent.	17 to 18 per cent.	18 per cent and above.		
					Per cent.	*Per cent.*
White Improved Imperial Élite	65	20	23	4	19.6	11.6
Vilmorin La Plus Riche	7	16	32	94	23.4	13.4
Vilmorin Improved, Schuyler Seed	4	8	5	3	18.8	12.4
Demesmay	11	14	5	40	22.0	9.6
Vilmorin Improved Élite (Dippe Brothers)	1	4	5	47	21.6	10.6
High Grade Commercial Kleinwanzlebener	19	30	64	107	22.0	13.6
Kleinwanzlebener (Holland)	0	1	9	50	22.2	18.4
Kleinwanzlebener Élite	6	15	24	165	22.0	14.6

PRESERVATION OF THE MOTHER BEETS.

The spaces in the beets caused by the removal of the diagonal core for analysis were filled with cotton saturated with formaldehyd. The beets thus prepared were placed in silos, where they will remain until March.

GROWTH OF SEED FROM THE MOTHERS ABOVE DESCRIBED.

Since the pollen of the beet is easily transported, it is necessary that each variety of seed be grown in plots entirely removed from any danger of fertilization from other localities. In order to secure this, one of the varieties preserved will be planted, through the courtesy of Mr. William Saunders, superintendent of the garden and grounds, in the Department garden at Washington and arrangements have been made with the following experiment stations to grow one variety each of the remaining beets, viz: Maryland; Ithaca and Geneva, N. Y.; Michigan, Wisconsin, and Iowa. As soon as practicable in the spring the silos will be opened and the beets forwarded to the stations above named for transplanting.

The beets of each variety of different degrees of strength should be planted as far removed as possible from the other classes. For instance, the beets in the grade of 20 per cent of sugar should be planted far enough from other grades of the same variety to prevent intermixing of the pollen. In this way the strain of excellence can be best preserved. The beets which have been saved for mothers are to be divided into classes representing different degrees of saccharine strength, and each of these classes planted separately to produce high grade seed for future use.

NECESSITY OF SEED DEVELOPMENT.

It is highly important for the rapid and safe progress of the beet-sugar industry in this country that attention should be paid to the production of high-grade seeds. We have in the United States such great differences in soils and climatic conditions as to render it evident that

a single station for the production of seeds would not be sufficient. Beets of different qualities should be developed in different localities. The character of beets best suited to the fields of New York and Wisconsin, for instance, would not be the ideal plant for the semiarid regions of Nebraska. On the other hand, it is evident that beets grown in an arid region, as, for instance, Chino and other valleys of California, without irrigation and with scarcely any rainfall, should have a longer tap root than those grown in localities where rainfall is abundant or irrigation is practiced. It seems plain, therefore, that three, if not four, stations should be established, and in order that this work may be conducted under uniform methods these stations should be established and maintained by the Department of Agriculture.

One of these stations should be located in an area of average rainfall and ordinary meteorological conditions as presented, for instance, by the States of New York and Michigan.

The second station should be established in a locality where a deficient rainfall is to be expected, and where the vicissitudes attending meteorological changes are the greatest, as, for instance, in South Dakota or Nebraska.

The third station should be established in a region where irrigation is practiced, as, for instance, in Colorado, New Mexico, or Utah.

A fourth station should be devoted to the development of a beet best suited to arid regions where irrigation is not practiced, as, for instance, in the coast valleys of California.

It is only by a careful, systematic, and scientific development of beets suited to these different localities that we can expect to promote in the most favorable manner the development of the beet sugar industry in the United States. It is evident that the continuation of the experiments which have been conducted by the Department of Agriculture for so many years in the analysis of beets and in the delimitation of areas suited to beet culture should now be supplemented by a more rigid scientific attempt to develop beets of characteristics best suited to the four typical localities which have been specified above. The maintenance of a small experiment station entirely competent to accomplish this work in each of the localities mentioned would not require a very great outlay of money and would result in the greatest possible good to the industry.

STATISTICS OF AMERICAN BEET-SUGAR PRODUCTION.

The information contained in the following table has been obtained through the courtesy of the beet-sugar factories:

Statistics of the production of beet sugar in the United States for the year 1897.

Number of factories in operation	9
Number of acres of beets harvested	41,272
Approximate average price paid for beets	$4.10
Approximate average per cent of sugar in the beets	14.49
Total pounds of granulated sugar made	90,060,470
Total pounds of raw sugar made	431,200
Granulated sugar obtained per cent beets	11.56
Raw sugar obtained per cent beets	0.06
Total sugar obtained per ton (2,000 pounds) of beets.....pounds..	232.4

Statistics of individual factories for the year 1897.

Name of factory and location.	Beets harvested.	Beets harvested.	Price paid per ton of beets.	Time the machinery was in operation.	Sugar content of the beets.	Total output of granulated sugar.
	Acres.	*Tons.*		*Days.*	*Per ct.*	*Pounds.*
Alameda Sugar Co., Alvarado, Cal	4,808	48,773	$4.00	90	14.20	10,198,648
Chino Valley Beet Sugar Co., Chino, Cal	9,678	97,197	(*a*)	151	15.10	24,303,122
First New York Beet Sugar Co., Rome, N. Y	700	4,325	5.00	45	(*b*)	*c*765,700
Oxnard Beet Sugar Co., Grand Island, Nebr	4,282	38,607	(*d*)	(*d*)	12.90	6,798,300
Los Alamitos Sugar Co., Los Alamitos, Cal	2,800	29,542	4.16	105	15.73	6,017,900
Norfolk Beet Sugar Co., Norfolk, Nebr	4,029	36,113	(*d*)	(*d*)	13.60	7,941,400
Pecos Valley Beet Sugar Co., Eddy, N. Mex	1,600	5,700	4.00	38	14.00	1,020,000
Utah Beet Sugar Co., Lehi, Utah	3,000	18,500	4.25	56	13.20	3,670,600
Western Beet Sugar Co., Watsonville, Cal	10,375	110,878	4.00	104	15.00	29,776,000
Total	41,272	389,635				99,491,670

a $3.50 per ton for 12 per cent beets, and 25 cents per ton for each per cent above 12. The Chino factory employed a saccharate process.
b Red beets, 5½ to 12 per cent sugar; white beets, 13 to 17 per cent sugar. Average analysis not reported.
c 431,200 pounds raw sugar are included.
d Not reported.

REMARKS ON THE BEET-SUGAR STATISTICS FOR 1897.

The past season was not very favorable to the production of beets in several localities in California and in New Mexico and Utah. Insufficient rain in California at the time of planting resulted in a smaller acreage being planted to beets and in a small yield of roots per acre. The great shortage in the crop reduced the quantity of sugar produced in California below that of the previous year, notwithstanding the fact that the new factory at Los Alamitos was operated and that at Chino increased its output.

The first New York beet-sugar factory was somewhat unfortunate in the varieties of beets selected. The red beets contained very little sugar, and undoubtedly decreased the output below what it should have been under favorable conditions. The white beets were of satisfactory sugar content. As may be noted by an examination of this report of the experiments made in the State of New York during the past season, that State is capable of producing beets of very great richness.

The shortage in the output of sugar is to some extent due to a decreased acreage at Lehi, Utah, and at Watsonville, Cal., these two factories having a larger crop in 1896 than they could work to advantage. In 1896 the factory at Watsonville produced nearly 20,000 short tons of sugar from approximately 150,000 tons of beets, and the past year 14,888 short tons from 110,878 tons of beets. The total production for the country shows an increase of approximately 5,000 tons in 1897 over that of 1896. The increase in the output of sugar next season, should more favorable conditions prevail in California, will be very large, since eight new factories, having a daily capacity of approximately 6,700 tons of beets, will be in operation.

The output is reported in the tables in pounds of granulated sugar, since but one factory marketed raw sugar. The quantity of raw sugar produced does not materially modify the statistics of the production.

REPORT OF SPECIAL AGENT

CHARLES F. SAYLOR.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SPECIAL AGENT,
Washington, D. C., February 15, 1898.

SIR: I have the honor to present herewith, for your inspection and approval, my report for 1897 as special agent and investigator of the sugar-beet industry, which is submitted in compliance with your instructions of April 10, 1897.

Respectfully,

CHARLES F. SAYLOR.

The honorable the SECRETARY OF AGRICULTURE.

THE EXPERIMENTS IN GROWING SUGAR BEETS IN THE UNITED STATES IN 1897.

The history of the experiments in growing sugar beets is probably not unlike that of any other agricultural product, except in this, it is more general. The sugar beet has so won its way with the farmer and business man in all parts of the country that it may now be said to enjoy national approval.

Most other industries having an agricultural or horticultural foundation have seemed to require conditions that localized the interest in them. This, however, is not so with the sugar beet. The writer of this report spent the spring, summer, and fall in the field, thoroughly covering all the States and Territories west of Missouri River, and, in addition, the States of Missouri, Iowa, Minnesota, Wisconsin, Michigan, and Illinois, and he has yet to find a State or Territory that is not thoroughly alive to the benefits of the beet-sugar industry and making efforts to discover its resources in this direction. And why should this not be the case? We will offer below some of the causes which, in our opinion, have led up to what appears a national sentiment touching this industry.

THE EXTENSIVE CONSUMPTION OF SUGAR.

The Department of Agriculture, realizing the diversified soil and climatic resources of this country and the benefits to accrue from the successful domestication of the sugar-beet industry, has undertaken as

a part of its active policy to secure to the people of the United States the business of producing $100,000,000 worth of sugar now brought into it for our consumption from the other countries of the world. It is a proposition that the people are ripe to consider. The transfer of this vast amount of business to our people from the countries of Europe, carrying with it, as it does, the employment of so much capital and labor, not only in the raising of the beets and in the processes of making the sugar, but in the consumption of raw materials, such as fuel, limestone, etc., makes the proposition at once a national, financial, and labor issue.

Our consumption of sugar has been rapidly increasing in this country. This is due not only to our rapidly increasing population, but to the fact that as our country grows older our people become more and more liberal in providing themselves with the necessaries and luxuries of life. There is also to be considered the increase in use from the constantly growing demands of the arts and sciences.

PRESENT STATUS OF THE INDUSTRY.

The beet-sugar investigation of the United States, so far as the Department of Agriculture is concerned, is confined to a study of the adaptability of the various parts of this country for growing the beets and of our facilities for entering into the successful manufacture of beet sugar in competition with Germany, France, Russia, and other countries which have achieved success along the line of this enterprise. At present the manufacture of beet sugar in this country is confined to Grand Island and Norfolk, Nebr. (under the control of the Oxnards), to Lehi, Utah (the Utah Sugar Company), and ranging down the Pacific coast, in the State of California, to four very extensive beet-sugar factories. The first factory is that of the Alameda Sugar Company at Alvarado, which was the first continuous beet-sugar factory in operation in this country, and has been in operation under varying experience of profit and loss for many years, having, however, had a successful record for the past seven or eight years. The second is that of the Spreckles Beet Sugar Company, at Watsonville, Cal., about 100 miles south of San Francisco, which is under the management and ownership of Mr. Claus Spreckles, who contributed so extensively to the development of Hawaiian sugar interests. The third factory is that of the Chino Valley Beet Sugar Company, at Chino, near Pomona, Cal., about 30 miles southeast of Los Angeles, under the control of the Oxnards. The fourth factory is that of the Alamitos Sugar Company, at Los Alamitos, about 30 miles southwest of Los Angeles, Cal., controlled by W. A. Clark and J. Ross Clark, of Butte, Mont. At Eddy, in the Pecos Valley of New Mexico, is situated another factory. At Rome, N. Y., a factory started operations in the fall of 1897. This completes the list of factories now in operation in the United States. At Omaha, Nebr., in New York State, in Michigan, and elsewhere, arrangements have been made to establish

factories, commencing with the next sugar-beet campaign. At Salinas, Cal., Mr. Claus Spreckles has made arrangements for constructing a factory with a larger capacity than that of any other factory known in the world.

The two Nebraska factories have a capacity of about 300 tons per day each; the Alvarado factory about 800 tons; the Watsonville factory about 1,100 tons; the Los Alamitos factory about 350 tons, and the Chino factory 800 tons. Factories in this country are able to extract in the neighborhood of 11 per cent to 13 per cent of sugar from the gross weight of the beets, and sugar beets range in the average of their sugar percentage in the various factories from 13 to 16⅔. In Europe farmers are required to do a great deal of fertilizing, while in this country we have sufficient lands to produce our sugar without fertilization—lands which will excel the production of Europe, both in tonnage and percentage of sugar and purity of beets; and now that Congress has arranged for a protective tariff, having in view the fostering of the beet-sugar industry, extensive experiments are being carried on in various parts of the United States in the culture and test of sugar beets. There can be but one answer to the question as to whether this country will eventually manufacture its sugar. We not only think that it will manufacture the hundred million dollars' worth of sugar that we now purchase, but we feel safe in predicting that, in this industry history will repeat itself, and the United States will be offering its sugar to the other countries of the world at a profit. Although the sugar industry has only had a run of about eight years in the United States in the few factories that have been established, yet, in that short time, those in control of these factories have revolutionized the process and materially improved the machinery; the implements of culture and the plan of agriculture in raising the beets have also been materially improved. In a few more years we will have so changed all the methods of growing, manufacturing, and refining beet sugar that the conservative foreigner will hardly recognize it as one of his original industries. The growing of sugar beets is the reverse of almost all other kinds of farming, in that the point to be attained is quality rather than quantity; in fact it is not farming, unless we consider it of the most intensive kind. It is the highest type of gardening, requiring much labor and attention; and the real problem that we have to meet in this country is to get our farmers to appreciate this fact, and to understand that the growing of sugar beets stands out as a special agricultural problem. If beets be given judicious attention and be grown properly, where the best conditions prevail, there is nothing that will reward the farmer so greatly, provided he has a market through the medium of a factory; but if neglected, or not handled properly, there is no crop that will remind the farmer so forcibly of his failure in these particulars when the harvest comes.

There is no doubt that the United States has a wide and varied extent

of land that will successfully grow high-grade beets, that the enterprise of the people of this country will appreciate this fact, and that in a short time all the sugar consumed in this country will be furnished by our own people.

The Sugar-beet Belt.

Working along the lines of the sugar-beet industry in the United States, it became a part of the duty of the writer to aid in establishing as nearly as possible a sugar-beet belt, comprising those regions in the United States which by their conditions of soil, moisture, and temperature will permit of the successful growing of sugar beets of a high grade of sugar content and purity. Of course, the sugar content, which refers to the percentage of sugar in the beet, will readily be appreciated as an important requirement by all. The purity refers to the constituent elements of the beet or to the absence of certain solids which are usually found in varying proportions among these elements. One demand of a factory devoted to the manufacture of beet sugar is a pure beet. Purity is not only intimately associated with the quality of the sugar produced, but it affects materially the process of extracting the sugar from the beet, and with an excess of impurities there is a material loss in the amount of sugar obtained. It is hardly possible in the process to eliminate all these impurities. If these impurities are present to any extent in the sugar there will be certain odors that can be easily detected by those accustomed to them when the sugar is confined in packages, barrels, etc. These impurities also have the effect of discoloring the sugar, which can be readily discovered by experts in sugar testing. Hence, the farmer will always be met at the factory door with the demand on the part of the superintendent for pure beets. In fact, all contracts made by the manufacturers with the farmers for growing sugar beets demand beets of a certain sugar content and purity. The standard in this country is usually put at 12 per cent of sugar in the beet, with a coefficient purity of 80 per cent. The three natural conditions that influence this sugar content and purity most are the physical properties of the soil; the moisture, either through irrigation or rainfall; and the temperature during the growing season. The sugar-beet region of the United States must, therefore, be such a region or belt as will admit of growing beets equal or superior to the above standard. In some of the bulletins and other publications issued by the Department of Agriculture on the sugar-beet industry a map has been published showing the region or territory in this country which, owing to the conditions of temperature through a series of years during the growing season, is particularly adapted to the growth of the sugar beet. This map was compiled from data in the Weather Bureau covering a series of ten years, taking 70° F. as the standard requirement for the growth of the beets during the growing season, which is considered to be June, July, and August; 70° F. was selected because a study of the temperature conditions of the most

successful sugar-beet regions of Europe showed that this was the prevailing average temperature for a series of years during the growing season there. This map has been considerably misunderstood by the public generally and by some of those intimately associated with the stimulation of the beet-sugar industry. It has appeared to some as though it was intended for an outline of the sugar-beet belt in this country, although in the references to it in all of the publications of the Department of Agriculture it has been distinctly stated that this was only a thermal map, showing where only one of the required conditions prevailed, that of temperature, which seemed best adapted in Europe to the growth of these beets. Of course, when an arbitrary standard like 70° F. is selected, the compilers of maps will have to draw their thermal lines as shown by the data on record, and it can be stated here that while this number of degrees may be the temperature condition demanded in Europe, still the fact that our conditions are so vastly different in other respects might modify the temperature demanded here. Under these circumstances, when we come to compile a thermal map in the future, as demanded by our experience in the growth of the sugar beets, for a number of years, it may show a somewhat different basis of temperature. This is all speculative, however, and future experience will probably give us a true temperature standard. One thing that the writer wishes to impress upon all interested is that the map referred to was based on a thermal standard entirely. It was intended simply as a suggestion, and never to show the actual sugar-beet belt of the United States.

It might be well to suggest in this discussion of the sugar-beet belt of the United States that the factories now in operation in this country, viz, at Rome, N. Y.; Grand Island and Norfolk, Nebr.; Lehi, Utah; Alvarado, Watsonville, Chino, and Los Alamitos, Cal., and Eddy, Pecos Valley, N. Mex., are all in the thermal belt shown on the map referred to.

THE WORK OF THE DEPARTMENT.

It will probably be interesting to the public to understand something of the policy of the Department of Agriculture with reference to the work it has inaugurated along the line of discovery of the actual sugar-beet belt of the United States—that is, to locate it by actual experiment and experience in growing the beets. These beets are to be tested for sugar content and purity, and then a study is to be made of soil, moisture, and climate. This will show the merits of each locality, after a series of experiments, where normal conditions prevail. In carrying out this policy 7 tons or more of sugar-beet seed were distributed over a large portion of the country, and about twenty-eight States participated in the experiment. As a rule the seeds were sent to the agricultural experiment stations to be delivered to the farmers from lists made up by the experiment station in the State. Some miscellaneous lots were sent out under the direction of Members of Congress and Senators, who furnished lists of names. In these cases the

seeds were sent direct to the farmer by the Department of Agriculture. In a few instances parties applied direct to the Secretary of Agriculture for the seed, indicating a strong interest in the enterprise, as well as a desire to test the growth of sugar beets in their respective localities. In such cases the seeds were sent. Bulletins giving directions for cultivating and harvesting were distributed with the seeds. The writer of this was directed to secure lists of the names of all parties to whom seeds were sent and who were participating in the experiments, and then to visit as many such persons during the growing season as might be possible. He was to note such facts as might be of interest, and to make a general study of the conditions, both for growing the sugar beets and manufacturing them into sugar; in fact, to gather all general practical information possible touching this industry. As stated, the seeds were sent to all parts of the country, and the State experiment stations entered actively into the investigation, North, South, East, and West; so that the results of the experiments will not only show to some localities that they are well adapted to sugar-beet raising, but it will demonstrate to others, probably, that they are not.

MODIFYING CONDITIONS.

We will refer to some conditions other than temperature that modify the sugar-beet belt. The sugar beet, like other farm products, requires moisture, although we believe that it is generally accepted that the sugar beet will succeed with considerably less moisture than the ordinary farm products, such as corn, wheat, oats, barley, potatoes, etc. The beets grow in the Mississippi Valley; in Nebraska they are grown commercially and under rain conditions. We have been informed by practical sugar-beet growers in Nebraska that the beets will succeed with considerably less moisture than is necessary for the other crops named, some persons putting it at less than one-half. The writer's observation has been that this is true, provided the physical conditions of the soil are favorable. It is believed that the sugar beet does not require so much less moisture, but that it has a propensity and better facilities for getting moisture after it has gone deeper into the soil. The sugar beet will send its taproot down as far as 12 or 13 feet. It is not unlike alfalfa in this respect. If we have, therefore, the conditions of soil that they have in a large part of Nebraska along the Platte Valley, the sugar beet will readily get its moisture. The underlying soil in a large part of the sugar-beet district of Nebraska has a moisture-bearing stratum from 4 to 6 feet in depth, and it is not uncommon to hear farmers say "we get our first water from 4 to 6 feet from the surface." The soil being loose and sandy and the subsoil being sufficiently penetrable, the sugar beet readily goes down to this depth. In its earlier stages it is aided in securing its moisture by capillary attraction, which, induced by proper cultivation, brings the water up from below. It might be said that one of the ideal conditions for growing sugar beets is a soil having a sandy or porous moisture-bearing stratum such as we have mentioned.

Sugar beets are grown where there are both rain conditions and irrigation. Such is the case with the beets grown for the Lehi factory in Utah. The growth of the beet is started with rains, and moisture is continued with irrigation. Of course these are conditions which might modify considerably the sugar-beet belt. Sugar beets are also grown entirely under irrigation, as, for example, the beets grown for the factory in the Pecos Valley, New Mexico. As this country is to demonstrate to the world what can be accomplished in the growing of sugar beets by irrigation, which has not been attempted to any considerable extent in Europe, it will probably show that irrigation will greatly modify our sugar-beet belt. Experience has shown that sugar beets can be successfully grown by irrigation, and our experiments are now showing that in the vast areas in the arid regions of Colorado, Utah, Montana, and other States which have natural facilities for irrigation, a high-grade beet can be grown successfully. When this is known, there is no doubt that the enterprise of these localities will take advantage of this fact to extend their resources. Sugar beets are also grown successfully without either rain or irrigation. This is the case with nearly all of the sugar beets grown in California. The sugar-beet grower of California takes advantage of the fact that his soil is thoroughly saturated with heavy winter rains and puts it in condition for planting the seed while the soil is sufficiently moist for its germination. The beets secure their moisture for the remainder of their growth from the moisture-bearing propensity of the soil, which is not yet fully understood. This moisture-bearing propensity seems to come from the drainage of the mountains which are saturated during the heavy rains of the winter, as the sugar-beet region might be said to be on the coast side of the mountain ranges in California. These lands are called by the Californians "damp lands," and the drainage seems to keep up during the growing season. The grower appears to understand fully the effect of capillary attraction in raising this moisture during the earlier growth of the beets, and aims to keep a dust mulch by cultivation to prevent excessive evaporation. There is a large region in California yet unimproved, and also some improved areas, which have conditions similar to those described and which can be utilized for growing sugar beets; in fact, we believe that California has demonstrated facilities so extensive and conditions so favorable to the beet-sugar industry that this State will only be limited in production by the extent of its market, modified by freight rates and shipping facilities.

PHYSICAL CONDITION OF THE SOIL.

The physical condition and properties of the soil are features that might be considered as modifying the sugar-beet belt. There has been mentioned above, under "Moisture," the physical condition induced by subirrigation. Now, while a great deal has been said and written about the kinds of soil desirable for growing sugar beets, it does not seem

that enough stress has been put upon the necessity of a desirable subsoil. It has been seen that the plant strikes deep down into the soil; this is its habit, and conditions are favorable only when it can do this without obstruction or interference from a hard or tough subsoil. The subsoil should be of a porous and penetrable nature. Hardpans and other stiff subsoils are fatal to the success of the beet. In regard to the surface soils, it has been found that there are quite a number of such soils in which the beets do well. It is generally admitted that a sandy loam is best; clay loam is considered good; and dark loams are also considered good if they are free from elements that stimulate impurities. New timber and brush lands that are considered very desirable for corn, potatoes, and some other crops are undesirable. These lands have a tendency to make a large beet and to give it too much opportunity for taking up impurities. Still, soils made from the disintegrated rock which has been washed down from the mountains into the valleys seem quite favorable for the growth of the sugar beet. The physical property of porosity is an important feature. The sugar beet generally succeeds well in any soil that does not become packed and hard, provided the soil does not contain undesirable plant-food elements. The best and only safe test of the soil as to its desirable or obnoxious elements is that made by experimenting with the actual growth of the beets in such soil.

ALTITUDE.

There is another class of influences that modify the sugar-beet belt. Take, for instance, altitude. There may be an extent of territory sufficient to support a beet-sugar factory where, on account of its altitude, the conditions are quite different from those prevailing in the surrounding country, and we have no doubt that there are a great many localities of this kind. It should be the aim of the people of these high localities, if they are interested in this industry, to test their conditions separately and apart from the experiments in other portions of the State. The trend of mountains and location of valleys modify materially the season in localities. Take, for illustration, the sugar beets furnished to the factory at Watsonville, Cal. Some of them are planted as early as February and others as late as April. Some are harvested as early as the latter part of July and others not until the latter part of the fall; thus showing that in a very small scope of country there is a material difference in the dates of the beginning and ending of the seasons, as affected by mountains, prevailing winds, etc. It might be interesting to note here that there is an important economical point in this difference of season in connection with the beets grown for a particular factory. It permits the factory to begin the harvesting of beets in the district where they ripen first and to continue the harvesting in districts according as they range in order of season. Of course, this

would not be true in any of the Mississippi Valley States, but it shows one of the advantages of the conditions prevailing in California.

Mr. Cutter, manager of the Lehi (Utah) factory, says of Utah: "All localities in our State where the elevation is not more than 5,000 feet and where they have about the same kind of temperature the beets show good results in sugar and purity." Throughout different sections in Colorado sugar beets are grown at an altitude of 6,000 feet. While talking with a gentleman at Glenwood Springs, Colo., who is very much interested in growing sugar beets in that locality, which is a very mountainous and broken district, we asked where he had grown those under the experiment he had referred to, he replied: "On top of the mountains you see around here."

The Importance of the Industry to This Country.

The annual import of sugar into this country is something like 1,800,000 tons. The valuation of this importation is over $100,000,000. We think that it will be generally accepted now as a fact that this sugar could be produced in this country at a profit. We believe that if the factories were built and in operation in those localities having the best conditions for the growth of the sugar beet, with the farmers thoroughly educated in its culture, the United States, with the superior natural advantages mentioned, could enter into free competition with the other sugar-producing countries of the world.

There will now be considered the home production of this amount of sugar under the present status of Government encouragement, which the writer believes is highly necessary to establish the industry. Leaving to the future the policy of the Government as to exercising a fostering care, we will suggest some of the great benefits that will accrue from this vast business of producing $100,000,000 worth of sugar.

RENTS AND VALUES.

The writer observed during his inspection of sugar-beet farms this summer that the owners of the land received in many instances as high as $5, in some cases $6, and in a few cases $7 per acre cash rent for land devoted to the raising of sugar beets, and this in localities where $3 per acre would have been the highest possible amount which could have been obtained as rent for similar land used for other farming purposes. Inquiry was made particularly into the value of land on which sugar beets were being raised around Watsonville and Alvarado, Cal., and it was rarely placed lower than $200 per acre. Rents were rated at from $10 to $15 per acre, yet these farmers claimed to be making a good profit raising beets. The sugar-beet lands of Utah were very much enhanced in value, so that the experience of this country up to the present time seems to be that the location of a beet-sugar factory in a district causes a healthy rise in rents and values of lands.

HIGH STATE OF LAND CULTURE.

Another important feature that must not be lost sight of is the high state of cultivation to which the lands are brought in raising sugar beets. The culture of the sugar beet must be considered really as the best type of garden culture. It requires deep plowing, careful pulverizing, and more careful tillage. It is intensive farming in every sense of the word. The value of a year's work in raising sugar beets must not be estimated entirely by the money received for the beets after they have been marketed, but the wonderful effect it has on the succeeding crops, both as to quality and quantity, must be taken into consideration.

The attention of the writer was drawn during the summer to the splendid condition of the soil where corn was being cultivated. The soil, which was absolutely clean from weeds, was soft and mellow, and the effect on the growing corn was marked. The attention of the farmer being called to this fact, he remarked, "Why should it not be? I grew sugar beets there two years ago." So we must realize that the extensive raising of sugar beets will bring the farms up to this high state of cultivation. It will also cause the farmer to observe the effect of this kind of cultivation, and will thus gradually lead to the same cultivation and better crops in localities where the sugar beet is not cultivated, resulting in better farmers in the future under the influence of the beet-sugar industry. To repeat, it will lead to better methods in the farming industry generally by offering wider opportunities for more systematic and economic rotation of crops and the better balancing of nitrogen furnishers and nitrogen consumers.

EMPLOYMENT OF LABOR AND DEMAND FOR CRUDE MATERIAL.

The introduction of this industry into this country means the employment of a large amount of labor, both directly and indirectly. The raising of sugar beets requires considerably more labor than any other farm product, and it is labor of such a kind and extent that no farmer doing considerable business could hope to perform more than a small portion of it. The farmer would receive enough for his beets to pay the expense in this direction, and of course would feel free to hire the labor, so that the raising of the quantity of beets sufficient to furnish the sugar demanded for our own consumption would call for the employment of large numbers of the laborers whose efforts are now employed in other directions, thus greatly increasing the avenues of employment. The sugar factories themselves would require many employees. In these two directions alone many people would receive employment directly in the beet-sugar enterprise. In addition to this the factories will have demands which will call for an extensive employment of labor in other branches of industry. For instance, they will be extensive users of fuel, and this would mean the employment of miners on a large scale and the remuneration of mine operators in mining and marketing the coal. The factories will also require considerable coke for

burning their limestone, which is demanded in large quantities for furnishing the carbonic-acid gas and lime necessary in the purification of the beet juices. This would require the employment by the coke producers of quarrymen and laborers. To build the factories and to place the necessary machinery in them to meet this great demand for sugar would mean the employment of many laborers—mechanics in building and mechanics in machine shops—both skilled and otherwise. Then we must consider that all these crude materials mentioned must be transported from their various sources of supply to the factories, and that after the beets have been worked and the sugar produced the finished product must be put upon the market and hauled to its destination. This means greatly increased freight transportation, calling for the further employment of labor. Then the extensive use of capital required in the building up and the carrying on of the industry is one of the most important factors to be considered.

BY-PRODUCTS.

There would be advantages to this country accruing from the beet-sugar industry in the stimulation it would give to corollary industries. After the juice is extracted from the beets we have remaining the beet cossetts, or pulp. This is known to be very useful and desirable feed for animals. In Europe it is extensively used in feeding. In this country it is gradually growing in favor as a desirable element in a well-balanced ration for animal feed. In another place in this report we shall give the views of a gentleman who is an extensive feeder of cattle and who has made many experiments with feeding beet pulp to animals in different rations against other animals that were not so fed, and he is very enthusiastic in his praise of beet pulp as a feed for animals. Some factories in this country are enabled to dispose of their pulp to a greater extent than others. It depends largely upon the education or information those engaged in the feeding industry have acquired in this direction and upon whether they have had an opportunity of availing themselves of it. Farmers as a rule seem to be slow in taking hold, but where they do give the pulp a trial it becomes a popular feature on their farms afterwards. Around some of the factories companies have been organized and arrangements made for feeding on a large scale. They are dependent upon the demands of the farmers, and it can be said that the demand for the pulp is constantly increasing. It is probable that in a short time the demand will exceed the supply. It is found to be very desirable for cattle feeding as well as for sheep, and for dairy feeding it is ideal. Dairies and creameries follow naturally in the wake of factories, and we think the introduction of beet-sugar factories in this country will afford the creameries and dairies an opportunity for providing a ration for their cows which will secure the best results. Three dairies have started in connection with beet-sugar factories in the United States, and since we have from 35 to 50 per cent of pulp from the original beet, depending upon the amount of pressure that is applied in extracting

the water before the pulp goes into silos or is hauled away, any factory will furnish a large amount of feed for the adjacent country, and it can be shipped by railroad or hauled profitably long distances by wagon. The pulp is usually preserved by placing it in silos at the factory, but it has wonderful keeping qualities, which are advantageous. At Grand Island pulp three years old was used for feeding purposes which had simply been hauled out on the prairie in large quantities and left there. After a few inches of the top were scraped off the pulp seemed to be pure and fresh and palatable. In fact, we are informed that this pulp was preferred by the feeder. At present pulp is sold from 10 to 50 cents per ton, depending largely upon the demand for it. There are places where the factories are giving the pulp away to the farmers in order to get them to use it and thus gain a knowledge of its utility for feeding purposes, as well as to get it out of the way. The disposal of this pulp, should it not find an avenue in the direction of feeding purposes, would be a serious question to the factories. The farmer will find in the future that it is a cheap feed; that he can conveniently store it and keep it; that he can easily prepare it for feeding and handling, and that feeding it will give good returns for a small outlay of labor and expense.

During the summer the writer talked with a gentleman who had been examining the fiber of the pulp with a view to experimenting with it for manufacturing paper. What this will lead to we do not know, but it is probable that experience will discover other uses for it, possibly as desirable as for feed for animals. The more a farmer has to do with this pulp the more he will see that he can make it a thing of value. In this way the demand for the pulp will increase, and when this demand becomes greater than the supply it will bring higher prices. While this will mean greater expense to the farmer, it will mean a better remuneration to the factory owner in his business, and the equilibrium between the farmer and the factory will be the better adjusted.

MOLASSES.

There is a very important residuum which occurs in the manufacture of beet sugar known as "molasses." This is an item of considerable importance, and it is receiving consideration at present, as it has since the industry was inaugurated. It has been and is desirable to keep this molasses at the lowest possible minimum. The amount of this residuum left after the sugar has been extracted depends largely upon the purity of the beets and the effectiveness of the processes of the different factories. Of sugar, it still contains from 16 to 25 per cent of "boiled stuff," depending largely on the purity of the beet and, as has been stated, the effectiveness of the process. It has a very bitter and disagreeable taste, because it contains all the impurities which were not eliminated originally from the juice, and also the impurities introduced during the manufacture of the sugar, and which could not be

wholly extracted. These impurities exist in a condensed form in this residuum molasses, and it is not to be considered in any sense as proper for human diet. The manufacturer looks upon it as an item of considerable importance, and he has been working with a view of turning it in some way to the profit side of his account. Experiments are being made in this direction. One set of experiments is to reduce the molasses to the lowest possible minimum. There have been different processes used for this purpose. We believe the "Steffen process" stands first. Considerable progress is being made in this direction, notably at Chino, Cal., where this process, improved by the factory, is being used with, it is understood, highly satisfactory results to the factory experts and superintendents.

In the Steffen process the sugar in the molasses is converted into a compound by adding a proper proportion of finely pulverized lime to a proportion of the solution of molasses, and the whole is cooled down to a low temperature by means of ice. A tricalcium saccharate is formed, and this is extracted from the solution by passing the whole through a filter. The juice is then heated to a certain temperature, about 190° F., when a further precipitation of this calcium sugar compound occurs, which is known as hot saccharate. This is separated again from the juice by means of a filter; the juice then is allowed to pass away in the sewer. The process deals further with this calcium sugar compound, which is sent back into the factory and suspended in solution of water, and carbonic-acid gas again introduced, which forms a union with the lime and precipitates the same as calcium carbonate. The juice is then further operated on in a manner similar to that employed for the regular juice found in the beet. This description is given more for the general public than for the benefit of experts, but it is pertinent to state here that through this Steffen process the factories are able to secure a large part of the sugar in this molasses that has formerly been a loss to them. There does not seem to be any doubt about the effectiveness of the process. It is simply a question of the expense, and it is hoped that further experience and improvements in this process will enable the factories to practically and profitably recover the sugar contained in this residuum. This matter has been mentioned here as an illustration of one of the sources from which the factories are hoping to reduce the cost of production.

There are other processes being used to recover the sugar in this molasses, and the feeling is quite hopeful that one or more of them will finally be improved and cheapened to such an extent as to be available for the work, and that the final loss of sugar in the molasses will be very considerably lessened. The writer was informed by a technical superintendent of one of the factories that there is a process known as the "alcohol process" of working the molasses to recover the sugar, and that through it, if the laws in this country were favorable to its use, this loss might be largely eliminated. In this process it would be

necessary to recover the alcohol by distillation after each operation, in order to save expense by using the same alcohol over and over again in working the molasses. This, however, would be a violation of the internal-revenue laws unless the factories met the demands of the Government as distillers, and this they could not afford to do.

ALCOHOL.

The factories are also working along other lines to reduce the loss in this direction. They are trying to discover useful and valuable by-products that might be manufactured from this molasses. One of the things that has been made from the molasses is alcohol. We believe that in some places in Europe they are making alcohol profitably from this residuum. Some of the factory people in this country claim that if the internal-revenue laws were more favorable and would offer more encouragement processes could be worked that would practically eliminate this loss in the molasses.

FOOD FOR STOCK.

A great deal has been done with the molasses in various mixtures to utilize it as a feed for stock by placing it in ground feeds and other rations. There are also places where it is mixed with leaves of the beet, and, after being allowed to stand in silos, is fed out in this way. It has been mixed with the pulp in certain localities. All these problems have received more or less attention from scientific and agricultural journals, and are said to be attended with quite favorable results. These matters, however, will undoubtedly be thoroughly tested when the beet-sugar industry shall have been fully inaugurated in this country, and we simply suggest them here under the heading of "By-products," so that the public may see in a general way that a beet-sugar factory may be useful in other directions than the direct production of sugar.

FERTILIZERS.

Molasses has been used more or less in restoring to certain soils those mineral elements which the molasses is known to contain, and it is understood that this has been attended in some cases with good results, especially in places where the soil is defective in these elements. It has been stated that lime is used in large quantities in the production of beet sugar, from 6 to 10 per cent being used to the ton of beets.

As the factories in this country have a capacity of from 350 to 1,000 tons of beets per day, it is easy to figure the large amount of limestone that is required. Most of this lime does service in a mechanical way, and results finally as a residuum. It will thus be seen that the factories have large quantities of this waste product in a pulverized or soft state. In all of the factories except one this material is simply a waste as far as the factory is concerned. It is used to fill depressions and holes should any exist near the factory. If not used in this way it

accumulates and forms large bulky ricks or piles, which are in the way of the factory. This waste lime would be very useful on some lands as a fertilizer. It can be easily hauled away by the farmer who has brought in a load of beets to the factory, and he can thus return to his home with a load of lime fertilizer for his farm. We understand that in Europe the value of this lime is appreciated and the output is largely used for fertilizing.

Around most of the factories large feeding centers are being established. As a result there are large collections of manure, which are scraped out of the way and formed into piles. This manure is readily given to the farmer for removal, and a thoughtful, frugal, and scientific farmer can utilize his time, after delivering a load of beets, to no better advantage than by returning with a load of feed in the form of pulp, a load of manure, or a load of lime fertilizer. In this way his time is economized and his land profited and enriched.

The beet leaves and that portion of the beet cut off in "topping" the beets are considered very valuable for feeding. It has been discovered that this course, however, has a tendency to exhaust the soil, and it is better to allow the tops and leaves to remain on the field to act as a fertilizer and thus preserve the soil. Much of the more valuable portion of the elements contained in the sugar beet which the soil needs for recuperation is in the top and leaves. This fact has become so thoroughly well known to the factories in this country that some of them even stipulate in their contracts with the farmer that the leaves and tops shall remain on the ground, which seems to be a wise provision.

The United States as a Competitor of Europe in the Beet-sugar Industry.

If we consider only those localities in this country that have the best conditions and facilities for taking up the beet-sugar industry and limit the territory simply to that portion capable of producing our own consumption of sugar, it might be said that the United States possesses some material advantages over Europe.

NATURAL FERTILITY OF THE SOIL.

One of the advantages in this country is the natural fertility of the soil. One of the strong items of expense in producing sugar beets in Europe is the costly fertilization which must be resorted to in order to grow them. We have looked over many of the European estimates of cost of raising an acre of sugar beets and find that $10 to $20 is not an unfair estimate for this purpose. The beets grown in this country are produced from the natural fertility of the soil, and our agriculturists generally believe that this will be true for some time to come.

AMERICAN INGENUITY AND ENTERPRISE.

From our history in other directions in the past, and from the interesting features that can now be noted in the beet-sugar industry, it is fair to count the ingenuity and enterprise of our people as among this country's advantages over Europe. Among the interesting things the writer observed in his visits to the beet-sugar factories in this country during the past year was the rapidity with which our people are changing the machinery of the factories, shortening the processes and perfecting them by improving the machinery, and lowering the cost of production by simplification. In this connection we might instance the factories of Lehi and Los Alamitos, all the machinery in which was made and designed in the United States, and it was with pleasure we noted that the factory people generally looked upon these two factories as models, especially the one at Los Alamitos, which was established later than the one at Lehi. It may be said that the factories of the United States are kept up to date with all improvements in factory work, and a large portion of their resting period after each campaign is utilized in overhauling and replacing some of their machinery with the newest and best of its kind. It is interesting to note in this respect that a large part of this replacement is with American machinery. One factory, after two years' use, took out in one division machinery that cost $35,000, made obsolete by American improved processes. This improvement has also gone on in the implements used in the cultivation of the beet. A firm in Illinois which, in the beginning of sugar-beet growing in this country, began a careful study of the needs and demands of the farmer in this respect, has put out a full line of implements to meet every demand of the sugar-beet grower, from seeding, through cultivation, to harvesting. These implements have been improved and kept up to date and form a wonderful and interesting comparison with the most modern implements imported from Europe. It was the writer's privilege during last summer to examine a cultivator imported from Germany by a gentleman who had come here from that country, where he had been a beet grower on a large scale, to embark extensively in the growing of sugar beets. He was growing at the time about 200 acres, and asked the writer to inspect this cultivator, which he said was the most modern cultivator in Germany. It required two horses to haul it, one man to guide or lead the horses, another to operate the guide wheel and keep the cultivator straight in the rows, and a third man to manipulate the cultivator handles. Thus we see that to operate this cultivator required a heavy team and three men. Four rows of beets were cultivated at once, and the work was successfully done. The same afternoon, while looking over the beet farm, we discovered an up-to-date American-made cultivator of the Illinois firm above referred to. This cultivator was doing the work apparently as successfully as the German implement and was not nearly so cumbersome. It was drawn by one mule and was handled by one man. It was

cultivating four rows, the same as the other cultivator, and it was the opinion of several beet growers present that this American cultivator with one mule and one man was doing as much work and as successfully as the other implement with three men and two large horses.

The same instincts that lead the American to better his implements and improve his machinery will probably lead the American farmer into a closer investigation of the sugar beet to understand its nature, relation to the soil, and habits of growth, to the end that he may adopt more effective methods of cultivation.

FAVORED MARKETS.

Another item of material advantage to our people is the fact that we live in a market that has to be supplied, and the European has to transport his products a long distance to reach the same market. A great deal of the territory that is showing first-class conditions for growing sugar beets and for manufacturing them into sugar is located around our Great Lakes, and the great centers of trade are easily accessible at low freight rates through competition of railroads and water navigation, and with the choice of transportation by either. The above are natural advantages.

The Fifty-fifth Congress at its first session placed a duty of 95 cents per hundred pounds on raw sugar not above 16 Dutch standard in color, and not above 75 degrees polarization, and then on a rising scale of 3.5 cents per hundred pounds for each additional degree for higher grades of sugar until it reaches 182.5 cents per hundred pounds on refined sugar of 100 degrees polarization. Where the sugar imported is higher in color than 16 Dutch standard, 12.5 cents per hundred pounds additional duty is charged. This is called differential. Where countries like Germany pay a bounty to the manufacturer of sugar there must be an additional amount paid on such sugar before it can be received into this country equal to the bounty paid on its production. In Germany this is 31 to 39 cents per hundred pounds, and in France it is more. This act puts all countries on an equal footing when they present their sugar at our doors. It also gives the American producer the benefit of the fact that the foreign manufacturer must forfeit his bounty to the United States Government before he can become a competitor with our manufacturers here.

COMPARATIVELY SMALL AREA NEEDED.

When we consider the number of acres needed to raise the beets for the production of our own sugar, in comparison with the vast territory of the United States, the amount seems small, and, indeed, the amount of such land is small in comparison with the extent of our territory that possesses conditions suitable for the purpose. The fact that we are in the infancy of this industry is to be considered an advantage at this time, in that it gives us an opportunity to select the best and most

resourceful section of territory for this industry. It should be our aim in building up an industry of this kind, where competition is close, where we are really feeling our way, and where large capital is required to inaugurate it, to utilize our best resources in the pioneer work. As the industry works its way up, asserting its possibilities and demonstrating its trade relations, we can bring into action our reserve resources when it is found that we can enter the other markets of the world. It must be kept in mind by our people that they not only have to meet the competition of other countries, but that they are entering into competition with each other in our own markets. There is, therefore, the strongest necessity for intelligent study of resources before embarking in the enterprise. It requires large capital to inaugurate and start a factory. As time goes on we will know more about our resources in this direction, and those localities having the very best conditions should be allowed to demonstrate the fact.

General Observations on Experiments of Last Year.

We found, as a rule, that the farmers were going more upon their own experience and knowledge of growing field crops than they were upon the directions given them by the Department and experiment stations. They seemed to think that these directions were superfluous, calling for work that was difficult and requiring the planting and the cultivation of the beets in a manner that was totally foreign to their experience, and therefore wrong. They failed to appreciate the fact that they were dealing with a new feature in farming, or one which they had hitherto neglected, and in modifying the directions they were violating some of the fundamental principles on which the success of the sugar beet for factory purposes depends. They seemed to look upon the experiment of growing the sugar beet as a thing in which there was no remuneration, and, therefore, a thing on which they could not afford to waste much time. In considering the experiment of growing sugar beets during the past year the general public may get an indication of the first great difficulty the industry in this country is to meet and master, and that is the education of the farmer to the necessities of the cultivation required. With a view of offering a suggestion that may help in the future, some of the facts that came under our observation in this work will be recorded, noting only experiments of growing sugar beets on small plats on farms miscellaneously.

Experimental Beet Plants.

It is the aim of the experiment to demonstrate the facts and conditions that might obtain in a general way by showing the result through efforts directed in a small way. The farmer, when he receives beet seeds, with the understanding that he will grow them on his farm, does so with the implied obligation that he will conduct the experiment according to the directions, whether they suit his notions or not. He

should know that the results of the experiment must stand on its own merits, whether good or bad, since it was undertaken simply to gain the facts. Any other course than this is not only worthless as an experiment, but is misleading. When a place is to be selected for growing the beets the farmer should have in mind, first, such a plat of ground as will be typical of the region in which he lives. The plat should also be typical of his own farm land, so that the results obtained will indicate what might be expected from his particular region or from his own farm. It was found that in selecting these plats it was too often the tendency of the farmer to take a piece of ground, either in his garden or field, which was not used, for one reason or another, in growing other crops. This plat of land would stand out as a sort of nondescript, and would attract his attention, the only basis of his decision for selecting it as a place to make the sugar-beet experiment. The objection to such a selection would be that it is not necessarily typical of any soils whose qualities he wishes to demonstrate. The following are some of the reasons, selected from hundreds of the same kind, given by farmers visited for their choice of plats upon which to grow sugar beets: "It was three-cornered." "Too low for a garden." "It was recently heavily manured, and thought it would grow good beets." "It was a new clearing, and I thought I could grow good beets" (and yet there might not be a hundred acres of new clearing in the country). "I could not grow anything else on it, and I thought I would try beets." "I had that ground left when I sowed my oats, and this will square the piece." "I had that small piece left, and I did not know what else to plant there."

The above reasons are entirely foreign to any which should have actuated a man in selecting a plat of land on which he was to make an experiment for growing sugar beets. As already stated, he should have chosen a piece of land, not the best or the poorest, but one that was typically representative of his farm and of the general farming region in his locality.

PREPARATION OF THE SOIL FOR EXPERIMENTS.

The preparation of the soil largely affects the success of the crop, and should be attended to with care. It should be the aim in growing sugar beets to grow them underground as much as possible. Any portion of the beet that appears above the ground is simply a loss. This is governed by deep plowing and close pulverization of the soil. The first plowing is generally done in the fall, followed by shallow spring plowing and harrowing. The soil is then ready for planting. It is sometimes rolled after planting, but this depends on the nature of the soil. The beet is now in a position to go down in the soil, in its earliest stages, with the least resistance. It was found that the farmers were loth to give the attention to the preparation of the soil which the proper cultivation of the sugar beet demands. Very few instances were found

where farmers had plowed their soil twice, or where subsoiling was resorted to, or where the soil had been reduced to that nicety of pulverization which is demanded. The farmer thought this was unnecessary. "It was not necessary for corn or other crops, and why should it be for sugar beets?" was a frequent expression, and yet experience in growing sugar beets shows that such plowing and preparation are highly necessary. It is highly necessary to follow the instructions given for the experiments, because an experiment is made to demonstrate the possibilities of growing sugar beets on a particular farm or in a particular locality, and if the beet is not given the proper opportunity to do so the experiment demonstrates nothing. In the end, if the farmer is to go into the business of growing sugar beets, either on an extensive scale or in a small way, he will have to resort to the kind of plowing described above, and if he does not care to take the trouble to secure conditions under which the beets can only be successfully grown his efforts in experimenting are wasted and will only result, possibly, in misleading him in the whole matter. This subject is treated of so fully because of the fact that so many failures in beet experiment have occurred during the past year that were due entirely to an absolute want of careful preparation of the soil and seed bed. While the ability of the American farmer as an agriculturist has been demonstrated, it must be stated that before he can make a success of growing sugar beets he must abandon some private notions that he has on the subject and study the methods of cultivating the beets on the lines laid down by the long experience of those who have grown them extensively and successfully for factory purposes.

PLANTING IN EXPERIMENTAL BEDS.

The beet plant must be limited in its growing space. If not it is liable to become too large. It must not have too much opportunity to take up from the soil those constituent parts known as impurities. Experience in Germany, France, and other countries has shown that the beets should have just so much space and no more; and yet in most instances where beets were grown for experimental purposes by the farmer the rows were placed 30 or more inches apart, frequently planted the same width as corn rows. In a great many instances they would be grown in one or two long rows, and in some places the beets were spaced out in the rows so that they would show up in rows two ways and could be plowed in two directions, like corn. To the query why the rows were not placed closer together and the beets nearer to each other in the row the answers were: "We have plenty of ground, and it is not so valuable here that we have to crowd the beets together like they do when they grow sugar beets in Washington." "We plant them that way so we can plow and cultivate them." "Nobody could cultivate beets where the rows were only 14 to 16 inches apart." These and similar answers showed that the idea was simply one as to value and

amount of land necessary for the experiment or having the beets arranged handily for cultivation, losing track of the fundamental principle involved—that to raise pure beets and get successful results generally they must be grown close together and limited to the space which experiment has directed.

CULTIVATION OF EXPERIMENTAL PLATS.

To grow sugar beets successfully, supposing the conditions to be favorable, the soil must be kept free from the grasses and weeds and the ground stirred so as to allow the air to do its work in conjunction with the sunshine and moisture in order to secure from the beet the results that are desirable after it has matured. This is where some of the laborious efforts necessary in growing the sugar beet successfully are expended. The soil is not to be kept simply passively clean, as would perhaps be only necessary for corn, potatoes, and some other crops. It must be kept clean in every sense of the word, as clean as a well-regulated garden. It was found to be too often the case with the plants where beets were being grown from seed sent out by the Department of Agriculture and the experiment stations that weeds were allowed to grow and stand. The plats were neglected for almost every other part of the farm. In talking with the farmer in these cases it was found that it was his "intention as soon as he got something else done that he had in hand to clean out the beds," and in some instances this was done. The effects, however, of allowing the beets to stand in that condition even for a short time could not be eradicated and would show bad results at the end of the experiments.

SAMPLING.

The directions regarding samples provided a method for securing average samples as to size, form, and quality of the beets, but the growers often disregarded the instructions, and selected what in their judgment were the best samples from those grown in experiment. The information derived from the analyses of such samples is entirely misleading. In the first place, if the beet specimens are secured, we get results that are not in keeping with the majority of the beets grown in that case. Hence, the information that the farmer and the public receive on this point is not accurate, and the tendency is to inspire hopes on the part of both that probably will not be realized. It might happen that the grower, in his attempt to get the best samples, is actuated by ideas of choice that will lead to securing the worst samples, and the result will be as misleading in this as in the first case. For instance, he is liable to select a large beet, which might be a test of good specimens in other crops, but which in the case of the sugar beet is the reverse. The sugar beet should range from 1 to 2 pounds in weight, but beets between these figures are the best samples. The factories in their contracts with the farmers in raising sugar beets

always limit the size of the beet—usually to 2 pounds—and if many beets are larger the crop is condemned or the farmer is docked. These large beets are coarse, and the sugar percentage and purity are low.

The sugar beets will grow to an enormous size, sometimes as large as 18 pounds; so that the farmer can readily observe that it is one of the nice questions in connection with growing sugar beets to hold his crop down to the proper size.

YIELD, OR "TONNAGE," PER ACRE.

It has been impossible to secure through these general experiments any accurate knowledge of the tonnage per acre that has been grown in the different parts of the country. It might seem a simple matter to take one of these small plats and get accurately the number of pounds of sugar beets grown and easily estimate the number of tons per acre from this fraction of an acre. It is, however, the opinion generally of the directors of the experiment stations, as well as the conclusion that the writer has formed from observation, that it is not possible to give any definite idea of the tonnage. This is an important feature of the information to be acquired in growing sugar beets in an experimental way, because it is the foundation upon which the success of growing these beets will depend as far as it affects the farmer, provided he can grow beets of sufficient quality, and it is to be hoped that from future experiments in this line more careful and accurate data will be secured.

One of the points to be observed on the part of the farmer, of course, is to get as large tonnage per acre as possible. This is a legitimate ambition, and this is the point at which he should aim, keeping in mind that he must grow a beet not larger than 2 pounds; a beet that will be acceptable to the factory and not be subject to dockage or rejection. The average tonnage where beets are grown for factory purposes varies in different localities. It might be placed between 10 and 14 tons per acre, yet farmers can raise a good quality of beet with a tonnage ranging as high as 25 tons per acre.

SMALL BEETS.

A great deal has been said about growing beets too large, and something should now be said about growing beets too small. A beet may be properly cultivated through a season, and yet, through lack of moisture or some such cause, attain only a small size. The tendency of such a beet is to be high in sugar and purity per cent. This is very desirable. But the objection to this kind of a beet is that it is neither profitable for the farmer nor desirable for the factory, because of the tedious work required in its handling. We noticed in looking over the analyses of many beets grown this year that in cases where a high percentage in sugar and purity is shown the beets are very small. This is misleading to the farmer, and apt to lead him to suppose that he can grow beets of this high grade profitably for the market, but such is not the case; he

can not afford to grow the small sizes. The experiment has only demonstrated what the sugar percentage is in these small beets, and does not give the percentage it would likely be in a large beet, such as the farmer could afford to raise.

[NOTE.—It might be thought by some after reading certain remarks under some of the headings in this portion of the report that the writer is inclined to be a little hypercritical, but we wish to assure any such person that such is not our intention. It was our instructions when starting out in this work to make careful note of anything affecting the beet-sugar industry, and we have simply offered a few suggestions along this line in the hope that they might lead to a more careful consideration of the subject on the part of those participating in sugar-beet experiments in the future. If we shall have accomplished this object or shall have been instrumental in furthering it we shall feel highly rewarded for making these suggestions.]

THE FACTOR OF INTELLIGENCE IN FARMING.

It has been our observation that some localities take up the problem of sugar-beet growing more readily than others. It is well understood that the community is like the individual, and has its peculiarities, formed, of course, from the characteristics of the people. For instance, there are in the United States communities which are German, Russian, French, etc. In these instances it often happens that these communities have grown from some colonization scheme which brought the majority of the people from the same part of the mother country, and in the case of colonies from Germany, France, and Russia it is very likely that the settlers came from the sugar-beet regions of those countries. Some of them may have had considerable experience in growing these beets, while others not having this experience have gained a knowledge of the nature of the sugar beet, the manner of its cultivation, and the amount of labor involved in its growth from the first-named class. A community of this kind is better equipped to begin the growing of sugar beets than a community without these advantages. In other parts of this country there are localities in which the intelligent American farmer predominates. In such localities the farmer who has his farmers' organizations is an intelligent reader of agricultural literature, takes an interest in farmers' institutes, and studies all opinions pertaining to his line of work; he seeks and appreciates any knowledge relating to anything that he wishes to accomplish; he meets his fellow farmer at farmers' meetings, and discusses new features in farming, or the introduction of new plants in his section. In a locality where these conditions prevail a factory can well be established, the promoters being sure of the best results from mutual and reciprocal relations, which ought always to exist between the factory and the beet grower. The factory may also hope to secure in such a district the best beets that can be grown, and, indeed, we think that it is to this class that the beet-sugar enterprise must look for the highest development of the sugar beet and the final victory of this industry in the United States over foreign competitors.

LOCAL PROSPERITY ATTENDING THE BEET-SUGAR INDUSTRY.

The prosperous condition of a town or a locality where a beet-sugar factory was in operation was one of the interesting features of this investigation. The two factory towns in Nebraska and the one (Lehi) in Utah may be cited as examples, because the factory interest of these places stands out more clearly as the one cause of this local prosperity. It may be said that there is no one in these towns desiring employment during the growing season of the sugar beet that can not secure it readily, and it was a wonderfully interesting sight, in traveling over the farms, to see persons of all ages, sometimes in long rows stretching entirely across the fields, employed in this industry. The statement of business men in these towns was that "anybody wanting work here can get it," and the result is that there is not a family of those depending upon daily labor but what has several members receiving weekly wages. There are probably more people here with savings bank accounts than in any other place of the same size. On Saturday afternoons and evenings the people appear on the streets well dressed, looking happy and contented, showing in every way the effects of prosperous conditions.

THE WORK OF THE EXPERIMENT STATIONS.

Justice would hardly be done to a full statement of our observations if attention was not called especially to the great work being performed by the agricultural experiment stations of the United States along this and many other lines in which the agriculturist and business man are interested. To test a State's condition thoroughly with reference to its capacity for growing sugar beets requires a great deal of labor at these stations, and in most of the States the station staffs are thoroughly alive to the importance of demonstrating the possibilities of the beet-sugar industry. They are sifting the matter to the bottom, not only in arranging for growing the beets all over their respective States, but in making a study of the soils, both by chemical and mechanical analyses, as well as the climatic and moisture conditions. They are also gathering data with reference to the facilities and opportunities of the States for operating factories. There is no doubt that these stations are doing a wonderful work in the United States. The results of this work, however, are coming on so gradually that most of us do not appreciate them until we are brought to realize them by comparing the past with the changes in many directions that have taken place in recent years. In analyzing the cause which has brought these changes about, the experiment stations will be found to be the strong factors at work. We are attracting the attention of those nations which have been supposed to stand first in the application of science to their industries, and foreigners are coming to us to make a study of our experiment-station work. The relation between the farmer and these

stations is becoming more pronounced, and they are gradually getting nearer to each other. The stations are becoming more practical and the farmer becoming more scientific.

ORGANIZED EFFORT.

In connection with what has been stated with reference to some defects of experimenting in a general way, such as have characterized the earlier stages of the experiments in raising sugar beets, mention will be made of some of the conditions under which the best experiments were being conducted. A great many sections have formed county and local associations for handling this work in an organized way. Some of them have gone so far as to raise the money preparatory to starting a factory in case the conditions of the locality are such as to justify it. Many of these organizations have exercised more or less supervision over the growing of the sugar beets in their localities, have held meetings where subjects pertaining to the industry, as well as methods of cultivation and other matters of interest, have been discussed. Other localities were not satisfied with a general supervision, or felt that the responsibilities and the inducements were such as to warrant them in going to more or less expense in getting before their own citizens and the public generally as complete and reliable data as possible. In these localities a fund has been raised and an experienced man secured from the factory districts, one thoroughly posted on the sugar beet and its methods of cultivation. Such a man has been placed in charge of the various plats, so that from his supervision he is able to give accurate data relative to the beets grown, the methods of cultivation, time of planting and harvesting, the tonnage per acre, quality of beets, moisture precipitation, amount of heat, etc. Such a report as this will not only demonstrate accurately the results obtained, but will give an idea whether the results secured were obtained under normal conditions, and whether or not they are liable to be permanent results. With such knowledge as this, those interested in a locality are prepared to meet the capitalist, and, with an intelligent showing of facts, conclusions are soon arrived at as to whether it is advisable to furnish the money necessary to operate a factory in that locality. If the conditions will not justify the establishment of a factory, the people are prepared to drop the further consideration of the question and give their attention to something else. Our view of the case is that this is the true method, and that it should be the aim of the experiment stations, and those interested in demonstrating the conditions for the beet-sugar industry, to cooperate strongly in encouraging in every way possible such organization. It will lead to accurate information and will be educational in the dissemination of knowledge regarding methods and requirements demanded by this industry.

General Suggestions for Raising Sugar Beets.

Long experience in the cultivation of the sugar beets has furnished certain rules which are general in their application and which govern the preparation of the soil, seeding, thinning, and cultivating the beet plants. There are other rules which are applicable according to the conditions that obtain in certain cases. We will give below some general requirements and suggest some others that have local application. Reasons for the requirements or rules are also given in some instances.

SOIL AND PREPARATION OF THE SEED BED.

There are many kinds of soil in which the sugar beet will thrive. It must, however, be a soil that is inclined to be loose and friable, and without a tendency to become packed and hard. The sugar beet has a tendency to send down its taproot a good distance when compared with some other plants. In order to produce a beet of right form and pure throughout, the soil must be such as will permit the beet to do this, and also permit it to embed itself wholly therein. If this is not the case, the tendency of the beet is to "sprangle" out, which it should not do. It should have a single taproot, which tapers off in a long thread-like appendage, striking down deep into the soil. It should grow under the soil as much as possible and the top portion should not stick out above the surface, because this will not only be deleterious to the whole beet, but will make it necessary to cut off that portion which projects above the ground before the beet is sent to the factory, causing that much loss to the grower. This suggests a reason for the deep plowing, followed by subsoiling, demanded in the case. The soil should be usually plowed about 8 inches deep, followed with a subsoiler that loosens to the extent of 7 inches more. Then it should be harrowed back and forth until it becomes thoroughly pulverized and softened. Here we have a condition that is necessary to germinate the seed and assure ourselves of a stand of beets. If seeds are sown in ground where the surface is inclined to be lumpy and cloddy, even if the lumps are quite small, the effect will be as follows: The seed are sown from a half inch to an inch in depth, and it will be remembered that the beet seed have a rough, dry husk with convolutions on the exterior, making it quite rough on the outside, with small depressions, so that they must be planted in a soil that is soft, for the purpose of having it press against the sides of the seed, filling up these little depressions in order that the capillary attraction may bring the moisture from the soil to be absorbed by the seed, and thus induce germination. On the other hand, if the soil is cloddy in the least these small clods are inclined to keep little air channels around the seed, through which the dry air circulates and dries out the seed, which finally dies, and thus our opportunity for securing a good stand is diminished, as well as the chance of securing a strong and healthy plant at the outset, so that

one condition requisite is a highly pulverized soil. It is usually the practice, in stirring up the ground preparatory to planting sugar-beet seed, to do the first plowing in the fall. The subsoiling is also done at this time. In the colder regions we thus have the benefit of the effects of freezing and thawing, which crumbles and pulverizes the soil, of which most farmers are aware. In the spring the ground is plowed again with a shallow stirring plow or a good cultivator, and this is followed by harrowing, etc., to prepare the surface. In the sugar-beet districts of California it is the rule for the farmers to do the larger part of their cultivating in the early spring. In fact, they aim to kill all the weeds they would have to contend against before the seeds are planted. The conditions there at this season are more advantageous for this purpose than in most other sections, because the winter rains and early germination bring the grass and weed seed out, and then the ground is cultivated and the weeds killed. Another crop of weeds is then allowed to germinate, when the ground is cross cultivated for the further killing of weeds. This destroys weeds and helps to get the soil in condition for planting. After planting there are no further rains, and of course there are no such opportunities for weeds to grow as there are in States where there are rain conditions. We have, however, found sugar-beet growers following this method of killing weeds to some extent and to good effect even in the Mississippi Valley, where weeds grow luxuriantly during the growing season of the beets.

PLANTING.

Under this and other heads we will consider implements that are used for the purpose in growing sugar beets, the depth of sowing the seed, the distance of the rows apart, the distance apart of the plants in the rows, and the amount and kind of seeds, etc.

Special implements or drills are used for the purpose of sowing sugar-beet seed. Some of these implements have special arrangements for sowing the seeds in ridges and others for planting them on level ground, the latter being more usually the case in this country. There are places in the United States where the conditions will permit planting beet seed in ridges, and these ridges are maintained throughout the cultivation with apparent advantage to the beet, in that it allows more readily the action of the air and sun; but we believe this planting is not considered good practice in most of the present sugar-beet regions. Where seed are to be sown on a large scale it is preferable, and at least more economical of time, to use the four-row seeder, which can be regulated almost to precision for sowing a definite number of pounds of seed to the acre. We find that the best practice in this country is to sow from 15 to 20 pounds per acre, with a leaning toward the latter amount. It is better to be a little out of pocket on account of seed wasted than a good deal out on the amount of beets grown, as well in the quality of the same, owing to a poor stand.

PLANTING AND CULTIVATING IMPLEMENTS.

The companies that make a specialty of implements for the cultivation of sugar beets have what they call a "full set of tools." In a case where the four-row seeder is used, a four-row cultivator is a part of the set. This is desirable, from the fact that the cultivator follows the same four rows and in the same order that the seeder planted them, so that if there is any variation in the rows planted from a straight line the same variation will occur in each of the four rows being cultivated. The person who is holding the cultivator handles and following it has only to watch one row, and if it becomes necessary to shift the implement to one side or the other, on account of a variation in that row, the same will be true of the other three rows. The implement companies have also a set of two-row implements that operate in the same way. The cultivators used in this country are usually drawn by one horse or mule, and we found that most of those who have had experience with both animals prefer the mule for this purpose. This preference has often been expressed to us. It is claimed that the mule is more compact for the same amount of power, and having smaller feet, when the width between the rows is narrow, say 14 inches, he is not so liable to injure the beet plants. It is claimed that the mule is more susceptible to training in this particular line of work, especially in following the rows faithfully. He needs less attention from the person holding the handles of the cultivator, who thus has more time to devote to cultivation. This one mule or horse is all that is needed to pull the cultivator, taking four rows at a time. The first cultivation is accomplished with small plows or knives attached to the cultivator, called "goose feet," "because they resemble very much the form, shape, and size of a goose's foot. The edge of the knife runs within 1½ inches to 2 inches of the beet, a knife running on each side of the beet plants in each of the four rows, the side next to the beet presenting a square surface. The cutting part, or rim, of the feet run from one-half to an inch below the surface, and parallel with it. It is thus seen that it is not the intention to stir the soil to any depth, but simply to run the knives under the surface for the purpose of cutting off the roots of the weeds and grasses and breaking up the crust of the soil. This is the usual practice in the earlier stages of cultivation. Later it is usual to replace the "goose-feet" knives with "bull-tongue" cultivator blades, so named from their similarity in form to a tongue. These cultivate down 3 to 6 inches. After the seeds are planted it is usual to roll the ground, and by this means compress the soft dirt thoroughly around the shell of the beet seed, as has been suggested. This practice serves well to accomplish this purpose except in localities where it is found to be undesirable to retain this smoothly rolled surface, when it is sometimes "roughened up," to prevent evaporation, by the aid of a harrow. This is done because the soil is quite sandy and the prevailing winds are very strong in the spring, so that where the ground is

very level the wind carries along with it, sliding over this smoothly rolled surface, small particles of sharp sand, which strike the sugar-beet plants, cutting them off even with the surface. This is very damaging to the crop.

WIDTH OF ROWS.

The rows are generally made from 14 to 18 inches apart, sometimes as many as 21 inches, and the plants should stand in rows, from 6 to 10 inches apart. These distances in both cases are governed largely by the character and responsiveness of the soil, it being evident that some soils require closer planting than others. We wish to call especial attention right here to the distances governing the separation of rows and plants, because it is a governing principle, and no farmer can afford to violate the directions in this case. We have shown elsewhere in this report that there is a tendency on the part of the uninitiated to do this differently for various reasons. They look upon it as a hard task to cultivate the beets so close together, etc., but no one who understands the nature of the sugar beet and feels a responsibility in the success of his crop will allow himself to violate the principle governing the proper spacing of rows and plants. Long experience with growing sugar beets for factory purposes has demonstrated that the space occupied by the beet in the field from which it draws its sustenance must be limited. If allowed too much space it becomes coarse in texture and quality. The sugar beet not only sends down a long taproot but it has numerous lateral roots which will, if allowed, reach out several feet in different directions, and if this latter effort is not arrested it is liable to assimilate too much of those elements which are recognized in the laboratory and in the factory as impurities. This is prevented by spacing the beets as closely together as is practicable, and, as suggested above, in limiting the distance between the rows and the plants in the rows. The writer once called a prominent horticulturalist's attention to the practice of some farmers of driving nails into the limbs of their apple trees, or wrapping them with wire, or in some other way injuring them to a certain extent, in order to make the tree bear. In reply (while he did not commend it) he gave as a reason for this practice that "it makes them bear fruit the next year," which, of course, we observed to be the case. On asking him what he thought was the governing principle that brought this about, he stated: "You arrest the growth of the tree, and it has to exert its energies in another direction, which it does by storing up materials for a fruit supply and starting fruit buds." Now, if we apply this principle to a sugar beet which has been wasting its energies in the direction of growth, etc., we may be able to discover the philosophy of this governing principle of spacing. It gives us a beet of the proper size and texture, which we must keep in mind is from 1 to 2 pounds, the ideal we are striving for.

THINNING AND BUNCHING.

It is customary, as soon as the beet plants get through the ground so that the rows can be readily discerned, to go over the field once with the cultivator with the "goose-feet" knives attached. This catches the first weeds in their early stages, breaks up the hard surface, and permits bunching and thinning to better advantage. Bunching is resorted to to save time and labor. A person goes along the rows, and with a sharp hoe cuts out the surplus plants in the row, leaving the plants in bunches from 6 to 10 inches apart, according as may be desired. This is followed by the person who does the thinning, who crawls along the rows on his hands and knees, and, selecting the most thrifty plant in a bunch, takes it between the first two fingers, with the back of the hand toward the ground; then with a quick movement of the fingers of the other hand he grasps the surplus plants and removes them from the soil. This is one of the most laborious features of sugar-beet raising. It can be done by girls and boys from 12 to 16 years old, who are very active in the work. In fact, this kind of labor can be used to a great extent all through the various stages of the cultivation of the beet. We have known farmers in their earlier experience with raising sugar beets who looked upon this thinning out as a great waste of seed, and would try the experiment of planting less seed the next year. This experiment usually ended in disaster, especially if the conditions for germinating the seed happened to be not very favorable, and it is not customary for the farmer to repeat this experiment very often.

THE TIME FOR THINNING.

It is a very serious mistake to allow the plants to become too large before they are thinned, and we noticed that the agriculturists at the different factories were particular on this point when scanning the work of the farmers who were growing beets for the factories. There is a tendency of the plants, where they are grown close together, to twine around each other, and the principle to be observed in thinning beets is to remove the surplus plants, leaving the plant that is to mature intact in the soil, disturbing its roots as little as possible. If other plants are twined about the one that is to remain in the soil, the larger these entwining plants become the more the entwined plant is disturbed in thinning. The beet plants send out their laterals very rapidly, and in thinning out the surplus plants these roots are liable to be more or less disturbed. The larger the beet that is to remain in the soil the more likelihood there is of its being disturbed, so that this thinning process must not be neglected. The beet plants that are to remain can be set back three weeks in this way, and in a dry season a number of the plants are likely to be killed, thus affecting the "stand."

CULTIVATION.

We have said considerable about cultivation in discussing the "Soil and preparation of the seed bed," as well as in describing the implements used in cultivation, and we wish to state now that harrowing is to be very strongly recommended in the cultivation of sugar beets. Three things must be kept in view in this cultivation: First, the beets must be kept absolutely free from weeds and grasses, so that the beneficial effects of the sun and air may be fully realized; second, the ground must be kept loose for the same purpose; third, in case of dry weather the soil must be kept stirred, in order that a dust mulch may be sustained to prevent evaporation of moisture. Frequent hoeing by hand is highly beneficial to the crop.

HARVESTING.

The time of harvesting is governed by the time of the ripening of the beets. This ripening is made apparent by the outside leaves of the plant taking on a yellowish tinge and drooping to the ground. An experienced eye soon learns to detect a field of ripe beets that is ready for harvesting, the whole field being colored to this yellow tint and the leaves showing this drooping tendency peculiar to the matured plant. The beets have now finished their work, and the next step of the grower must be governed by his locality. If he is in a locality where there is a probability of rain, the beets must be harvested and placed in silos. This would be the case in most of the sections where rain conditions prevail, such places usually having strong rains in September and October, followed by more or less warm days. The effect of the rain will be to cause the beets to begin growing again and new leaves will soon be noticed starting out, as well as new lateral roots from the beet in the soil, all the beets showing a general tendency to a second growth. Serious damage to the crop will soon be done in this way. The sugar content of the beet goes down materially and its impurities increase, so that if the rains are marked and followed by warm days, it is possible for a whole crop to be lost, so far as their fitness for factory purposes is concerned.

SILOS.

It is the custom in localities of this kind to haul the beets to the factory if possible, and if it is not possible to do this they are gathered and placed in long ricks or piles on the surface of the ground. The base of these ricks or piles is from 3 to 3½ feet, with a height of 3 to 4 feet, tapering toward the top. Along each side of these ricks several furrows are run with a stirring plow in order to loosen the dirt. The ricks are then completely covered with this dirt by the aid of shovels. This covering is put on to the depth of about 6 inches, occasionally air spaces or ventilators being left on the tops of the ricks, which are usually made by the use of tiling or small elongated wooden boxes or

simply straw, the purpose being to prevent fermentation. Storing the beets in this way is called siloing, and the ricks or piles are called silos. These silos are closely watched, in order that no heating may occur and cause fermentation, which lessens the sugar content of the beet, and they are opened occasionally for this purpose. It is the aim of the grower, as already stated, to get his beets to the factory as soon as possible, but this will depend on "his turn." In case he is delayed in this way until cold weather comes on, these silos are covered with straw manure, straw, or someting of that sort, and then an additional amount of dirt is thrown on the straw covering. In this way it has been found that the beets will keep in very good condition until the last of January, if necessary.

It might be stated in this connection that it does not necessarily follow that the beets are lost even if they should be frozen solid, as the factories can readily work them frozen; and, in fact, some factory superintendents have told us that they prefer to work frozen beets. The one thing to be guarded against in the case of frozen beets is that they must not be allowed to freeze and then thaw. In California, where rains or freezing are not liable to occur, after the beets have ripened and have gone into this state of rest they are allowed to remain in the field until the grower is notified by the factory that his beets must be delivered, when they are harvested and taken to the factory. Thus the expense of siloing is avoided.

HARVESTING IMPLEMENTS.

Harvesting is accomplished by means of an implement especially prepared for the purpose. We have seen several kinds of these implements, all of which seemed to do the work admirably. In some places it is done by means of a long slender plow, which works on the principle of the stirring plow. It goes deep down into the ground with a sharp plowshare. This plow is run close to the beet in such a way that the share cuts the taproot just below the enlargement of the beet, at the same time loosening, lifting, and laying it on its side. Another harvester, instead of having a share, has two prongs, one of which passes on either side of the lower portion of the beet root; the space in front between the two prongs being larger than that in the rear, causes the beet root to be forced into the smaller space between these prongs as they pass by, and the beet is lifted bodily 3 or 4 inches and the taproot broken. As the plow passes on the beet drops back into its place loosened and ready to be lifted from the ground by the hand. Following the plow are persons who pick up these beets and by one stroke with a large knife made for the purpose separate the crown of the beet together with the leaves. This is called "topping," and it is the aim of the person doing this "topping" to make the cut where the line of the beet shows that portion has projected above the ground. Where the beet has been grown entirely under the ground only enough is cut

off to carry with it the crown and the leaves. If the beets are to be sent to the factory at once, the "topper" simply throws them in piles, from which they are taken and placed in sacks and put in wagons for delivery to the factory. They are sometimes thrown loosly into the wagons from the piles. Most of the factories, however, have arrangements for quickly handling the beets. Some of them have wagons provided with nets for receiving the beets, and upon reaching the factory these nets are taken from the wagons by the aid of machinery, and their contents dumped into the beet sheds. At other factories the wagons are hauled upon an elevated driveway, which is arranged in such manner that the portion on which the wagon rests can be tipped, and the wagon tipping at the same time, the load of beets is precipitated into the beet sheds. By either of the above methods the beets in the wagons are very quickly handled at the factory, and the advantages of these arrangements can be appreciated when it is known that long lines of wagons, loaded with sugar beets, stand ready at the factory to be handled. Either of these arrangements quickly dispose of many wagon loads, and teams are not required to wait long, as would be the case if unloaded in the ordinary way of shoveling out of the wagons into the shed.

IRRIGATION.

It has been stated that beets can be grown successfully under irrigation conditions, and in fact two factories in the United States, one located at Lehi, Utah, and the other at Eddy, in the Pecos Valley, New Mexico, secure their beets entirely through irrigation. There is a large amount of land in this country available for this purpose in Western Nebraska, Colorado, Utah, Montana, Wyoming and other States having like conditions; and this industry is one that should appeal to these sections on account of their already well-known grazing resources and the fact that stock feeding and dairying are so intimately related to the beet-sugar industry. The first beets that were ever successfully raised by irrigation for factory purposes were grown at Lehi, Utah. We believe that it is maintained in Europe that beets can not be successfully grown by irrigation—at least it is seriously questioned—but the experience at Lehi, Utah, and Eddy, N. Mex., has forever exploded this theory. There are a few things that must yet be learned about the application of irrigation to growing sugar beets, but these obstacles are fast being overcome, and the two factories mentioned are teaching the world lessons along this line, and in doing this are demonstrating the possibilities of the vast resources of the territory in the West having like conditions. Irrigation is especially adapted to raising sugar beets where the particular region is favored with rainfall in the earlier stages of planting time. The ground is moistened through rains, and in this way the seeds are germinated and started on their first growth. Experience has demonstrated that irrigation should be

held off as long as possible and applied as little as possible. Water should not be applied by irrigation until the natural supply has failed, and even then the grower must be careful not to apply too much. Too much is as disastrous as not enough. We have learned by talking with those experienced in the application of water by irrigation of the tendency of the land to dry out quickly after being irrigated and of the ground to become packed, so that cultivation must follow as soon as practicable after irrigation. It has been noticed that the beet has a tendency to send down its taproot deep into the soil, and especially is this true in the earlier stages, if the necessities of the case demand it in order to procure moisture; and this is to be desired. If water is applied too lavishly in the beginning this tendency of the beet is arrested, and it shows a disposition to rely on artificial supply of water rather than to seek its own, and we have thus interfered with a natural tendency that is desirable in the growth and maturity of the beet. The effect will be, under these circumstances, that the taproot will divide and the beets will become bunchy and sprangle out, assuming a form entirely undesirable. The beet may show a tendency to slightly droop its leaves and to become lighter in color, but this does not indicate that irrigation is needed. If the beet recovers its vigor in the evening it is a sufficient indication that it is getting along all right. When it comes to suffer from drought the tendency will be to droop and get darker in color, and it will not apparently recover vigor with the approach of the cool of evening. This is the time to consider the question of applying irrigation.

We have noticed two methods of irrigating beets, either of which seems to accomplish the work successfully. One of them is to plant the beet in rows, say, from 18 to 20 inches apart, and then when it is desirable to turn on the water, a small furrow is run between every other row by the use of an implement made for this purpose. The water is then turned on and allowed to trickle down these furrows. This causes the water to pass down on one side of every row in the field, and leaves the space between every other row that is not so furrowed. When it becomes necessary to apply water again a furrow is made between the rows not furrowed before, the former furrow having been leveled up by cultivation. The second plan is to plant the first two rows the usual width apart, say, from 14 to 20 inches, and then the next space between the other two rows will be considerably wider, say up to 26 inches apart. This wider space is entirely for the purpose of having an irrigating furrow, which is made in similar manner to the one described above, the wider space occurring between every couplet of rows. In either case water can be held in these furrows by throwing a shovelful or two of dirt into the furrow in front of the water until the ground becomes thoroughly saturated around the beets, and then the obstruction is removed and continued down the furrow. Of course the supply furrows are conducted along the higher places and the cross furrows arranged in such a way that all parts of the field are reached.

This simply suggests that the grower in the application of water by irrigation must thoroughly understand the science of economically distributing the water in the field, which is a question too broad to be entered into here, but by experience the farmer becomes more or less adept.

In regions where the beets are started in the spring with moisture from rainfall it is the aim of the grower to produce his crop with four or five irrigations of the beets. After they begin to ripen all irrigation must cease, for the same reason that it is not desirable to have a rainfall after the beets are ripe.

SUBIRRIGATION.

Simply as an interesting observation of one of the wonderful provisions of nature, we will call attention to the moisture conditions under which beets are grown on the Pacific Coast. As has been stated, beets are grown there without the aid of either rainfall or irrigation. There seems to be some sort of mechanical provision of the soil for holding the moisture precipitated during the winter, and gradually letting it out during the growing season of summer. This same condition prevails in the eastern part of Washington and in many sections of what might be called the arid regions, so far as the amount of rainfall is considered. In a trip made between Spokane and Pullman, two towns in eastern Washington, we saw some splendid fields of wheat, oats, and crops of like nature, but we wish to refer especially to the wheat, which both in quantity and quality was superior to anything we observed anywhere else in the United States. These fields of wheat were located on hills, which in some cases reached the magnitude of small mountains. All over the sides of these elevations and on top of them were growing these fields of wheat, that were yielding from 40 to 60 bushels to the acre of fine quality, and, indeed, it was believed that on the top of the hills the crops were doing better than on the other portions, if possible. Now, the rainfall during the growing of these crops was hardly worth mentioning, and yet this wheat had grown, matured, and was harvested as described. We could not imagine for a moment that such crops could grow on such hills anywhere in the Mississippi Valley under any conditions with which we are acquainted. We think that these crops are due to the inherent tendency of the soil to retain and emit moisture. We believe that experts and scientists are unable satisfactorily to explain this phenomenon. We have called on some experts for an explanation, and they state that they are working on the problem, but so far are unable to solve it. One of these experts informed the writer that he had noticed a place where a second growth of tobacco and other succulent plants had occurred, and right in this spot an 80-foot well had been dug without the slightest show of water. Scarcely any rain had fallen in this locality since the early spring. We can only say that the moisture is there in the ground and

is given out to the plants, as has been described in the case of the fine wheat crop. These peculiar conditions prevail over extensive sections in the western mountain regions, as well as in the part of Washington referred to, and along the coast of California. It is under such conditions as these that they grow sugar beets in California for the factory.

BLIGHT IN BEETS.

We noticed during the inspection last summer that in some sections, especially in the arid regions, where beets were raised by irrigation, that the beets were liable to be affected by disease or blight. This disease seemed to attack the taproot at a considerable distance under the surface and then gradually work up through the body of the beet, the lateral roots feeding the beet and keeping the leaves green during the progress of the disease. The diseased part would rot completely, and finally the whole beet would be consumed in this way, the disease generally completing its work when the beet was about two-thirds grown. After this the leaves would die, the disease having consumed the beet, and thus killed the lateral roots which had fed them. A very sour odor could be detected during the prevalence of this disease. We are not prepared to say whether this blight is peculiar to irrigated beets or not, but we found this disease throughout the regions where the beets were grown by irrigation. We found irrigated fields, however, where the crop was not affected in this way, and some fields where the beets were only slightly affected. If the disease is due to irrigation, the people who irrigate will have to tell us by experimenting with the disease how to overcome it. It seems that the trouble was caused by intensely hot weather and irrigation together, and it occurred to the writer that if the colder days and nights were selected for the time of irrigation as far as possible, it would be better for the beets. On this point Mr. Cutter, of Lehi, says: "Irrigation has nothing at all to do with the blight of root on the part of beets. There has been blight of beets in several localities this year, whether irrigated or not. It is simply a secondary consideration; the primary cause being the lack of moisture."

CONDITIONS IN THE SPRING OF 1897.

In the Mississippi Valley the ground was too wet for the early planting of the sugar-beet seed, hence the planting was delayed and the spring season of 1897 was unfavorable. In northern Iowa, South Dakota, Minnesota, and Wisconsin unusually late frosts occurred, which affected the beets. We believe the spring was quite favorable in Nebraska for the growth of the beets. Throughout Colorado, Utah, and the coast region there was an unusual drought at the time when the seeds should have been planted, and the conditions were quite unfavorable for the raising of a crop. Cutworms very materially affected the young plants in South Dakota, and in the northern section

of New Mexico insects attacked to an alarming extent the sugar beets being grown for the factory at Eddy, in that Territory. It might be stated, therefore, in a general way, that the year of 1897 was not a very favorable one for the sugar-beet crop.

VALUE OF CROP.

We have considered the question of raising sugar beets, the different methods applied in cultivation, and the agricultural problems to be worked out in connection therewith. We will now consider the value of the crop.

The worth of a crop of beets to the farmer will be different in different localities. In order to encourage the growing of sugar beets some of the States have offered a bounty, say $1 per ton, or so much for every ton of sugar produced. In some cases the bounty is to go to the farmer, and in other cases it goes to the factory, with the condition that the factory will pay the farmer a certain price for the beets. The usual price of beets outside of this government encouragement is $4 per ton—that is, where the beets are purchased straight without reference to their purity or sugar content, except that they be standard. It is usual for the factory to establish a standard to which all beets that are delivered must come, and before they are received the beets are tested for this purpose. This standard usually requires that the beet shall contain 12 per cent of sugar and show a purity coefficient of 80 per cent. Beets lower than this standard are rejected or docked. Some other factories purchase beets from the farmer and pay for them according to the amount of sugar contained. Such factories usually fix 12 per cent of sugar as the basis upon which they will pay, say $3.25 to $3.50 per ton, increasing the price 25 cents for each additional 1 per cent of sugar shown in the beet. For instance, if $3.50 was the price for standard 12 per cent beets per ton, and beets should be delivered that showed 14 per cent sugar, the farmer would be paid $4 per ton, and for beets showing 15 per cent he would receive $4.25.

The amount of beets that can be grown per acre will depend largely, like other crops, on the stand and responsiveness of the soil, as well as the cultivation the crop has received and the favorableness of the season during the growing time. It is difficult to state accurately what the average tonnage per acre should be. As stated, this varies for different localities and different seasons. It would be safe, however, to put the average crop at from 10 to 14 tons of beets per acre, and the maximum and minimum at 30 and 6 tons. A great many estimates have been made as to the cost and profit of growing sugar beets. These, again, will vary in different localities and seasons, as well as for different people. Some persons will not accomplish the same results with the same amount of effort that others will. In this connection, two estimates, one for beets grown for the factory at Lehi, Utah, made by the factory superintendent, Mr. Granger, and the other for

beets grown for the factory at Norfolk, Nebr., are presented. The following is Mr. Granger's statement, and the writer, speaking from personal acquaintance, presents the figures as entirely trustworthy:

The figures given below are not theoretical, but represent the actual cost per acre of the work with wages at $2.50 to $3 per day for man and team; $1.25 to $1.50 per day for man, and 50 cents to $1 per day for boys.

Fall plowing, 12 inches deep	$2.75
Pulverizing in spring	1.00
Rolling	.25
Planting	.35
Fifteen pounds of seed, at 18 cents	2.70
Rolling previous to thinning	.25
Cultivating previous to thinning	.50
Thinning	4.50
Hoeing after thinning	2.00
Furrowing out for irrigation twice, at 25 cents	.50
Irrigating twice, at 40 cents	.80
Cultivating after irrigation twice, at 50 cents	1.00
Plowing beets out at harvest time	1.50
Pulling beets after plow	2.00
Topping 13 tons, at 35 cents	4.55
Sacking and hauling 13 tons (3 miles), at 65 cents	8.45
Total expenses	33.10
Yield, 13 tons, at $4 (this price paid at Lehi)	52.00
Net profit per acre	18.90

The above figures may, in some instances, be subject to slight changes, but in the aggregate they are correct.

The very conservative estimate of only 13 tons per acre is used here merely to show what size crop can be made to pay well.

By figuring on a yield of from 18 to 25 tons per acre—which is not at all extravagant—the possibilities of the crop may easily be recognized.

A great number of farmers who raise beets for the Utah Sugar Company make a net profit of from $30 to $50 per acre, after allowing themselves and family full wages for all work done on the crop.

The following is a statement of expense and net returns from 41½ acres of sugar beets grown at Council Bluffs, Iowa, by H. C. Graves & Sons, and shipped and delivered to the Norfolk Beet Sugar Company, at Norfolk, Nebr.:

Statement of expense.

	Total cost.	Cost per acre.
Preparing 41½ acres	$81.00	$1.95
Bunching and thinning plants	153.10	3.69
Replanting by hand	32.60	.78
Hoeing four times	102.70	2.50
Cultivating weekly for six weeks	137.85	3.30
Digging	84.10	2.05
Pulling and topping by hand	283.75	6.83
Hauling to cars	285.95	6.89
Seed	100.20	2.41
Machinery	38.75	.93
Total	1,300.00	31.33
Freight to Norfolk, Nebr., on 717.37 tons, at $1.25 per ton	896.71	.....
Total cost of crop laid down in Norfolk	2,196.71	.....

Statement of returns from beets.

$5 per ton for 654.1 tons	$3,270.50
Allowance received and for tops for cattle feed	229.67
Rebate to us on shrinkage in shipment	24.00
Total receipts	3,524.17
Cost	2,196.71
Net profit for use of land	1,327.46

This gives $31.98 per acre for use of ground. Total acreage, 41½; total tonnage, 654.10; average tonnage to acre, 15¾; average tare, 8.83 per cent; average sugar content, 14.39 per cent; highest purity, 84.2 per cent; lowest sugar content, 11.8 per cent; highest sugar content, 17.1 per cent.

The following figures show net result if we could have delivered to a factory at Council Bluffs and saved shipment to Norfolk:

Gross weight of beets at this end before shipment	1,513,330
Gross weight of beets at Norfolk after shipment	1,435,200
Shrinkage in weight in shipment, 5.2 per cent, or	78,130
Leaving a net loss to us in shrinkage in weight	$171.82
We paid in freight	896.71
Net loss to us because of having to ship beets	1,068.53
Net profit as shown above after shipment	1,327.46
	2,395.99

Showing that we could have made $2,395.99 if we could have delivered to a Council Bluffs beet-sugar factory. This would have been a profit of $57.73 per acre.

A sugar manufactory at Council Bluffs having a capacity of 300 tons of beets per day will produce almost 6,000,000 pounds of sugar in a season. It will pay to the farmers for beets, at $4 per ton, $112,000. It will give employment to 150 men in the factory, in addition to 500 or 600 men, women, and children in the beet fields.

Beets grown here this season tested as high as 17.1 per cent, and averaged almost 15 per cent, which is fully 5 per cent above requirements of German beet-sugar manufactories. There are many thousands of acres of land adjacent to Council Bluffs fully as well adapted to sugar-beet raising.

[NOTE.—The amount received for the beets is too large, according to present prices, which are about $4 per ton. The above parties received $5 per ton on account of the State bounty of $1 per ton paid at that time, so $1 per ton should be deducted. Attention is also called to the heavy freight charges in the above statement, which are due to the fact that the beets were hauled to the cars and shipped nearly 100 miles. The item of "hauling to cars" is equivalent to the delivery to the factory.—C. F. S.]

BEET SEED.

The question of buying beet seed is one of considerable importance. There is a disposition on the part of the people to be dissatisfied with the custom of importing the larger portion of our seeds. The feeling seems to prevail generally that these beet seeds can easily be, and should be, grown in this country. This is a spirit to be commended, but when it is understood that the growing of sugar-beet seed is one of the most intricate features of the whole enterprise, requiring a large investment of capital and the application of considerable scientific knowledge, it will be readily seen that it will be some years before the United States will have fully established a safe and reputable sugar-beet seed production. These seeds are not produced in the same

manner as ordinary garden seeds, such as cabbage, turnip, lettuce, etc., simply by planting out the beets and harvesting the seeds at the end of the year. They are produced in a series of plantings, and, according to the best information, it takes five years to realize a crop of sugar-beet seed after the series has begun. The series is required in order to produce seed of a high grade and sure quality, and is the result of testing and selection. The sugar content and quality of the beet is held up by this constant testing and selecting, and it is a matter of vital importance. The sugar beet, as such, is of too recent origin to have its habits of sugar producing so thoroughly fixed that we can depend upon it. These are facts that we must be absolutely sure of, as they lie at the foundation of success in the sugar-beet enterprise. Under these circumstances we must depend upon the old established and thoroughly equipped firms of Europe to produce our sugar-beet seed until such time as we can gradually and safely raise our own seed. There are undoubtedly firms in Europe which will, whenever they can, impose a poor quality of seed upon the American or any other purchaser. It becomes a matter of the greatest importance to the people in this country to be sure of the character of the firm from which they intend to purchase sugar-beet seed. Buyers should surround themselves with all possible safeguards in these transactions. In the first place they should understand thoroughly the responsibility of the firm, and in the next place they should buy seeds in original packages when they purchase abroad, and should demand an official certificate showing a test of their quality, germinating power, etc.

When these seeds are intended to be used in quantities, they should be thoroughly tested as to their germination upon arrival. Seeds can be imported wholesale into this country for about 9 cents per pound. We understand they have been bought recently for next year's use for something less than this. When we shall be able to safely produce our own seed, it will undoubtedly be to our advantage, as the tendency will be to build up, establish, and perpetuate the sugar-producing habits of the plant under our own climatic conditions.

Factory Conditions.

Conditions that would largely apply to the agriculturist or farmer in answering questions as to whether he was in position to profitably grow sugar beets have been considered; but in considering the beet-sugar industry there is another side to the question, which might be called the factory side. It might be possible to grow successfully sugar beets, and yet the local conditions might not be favorable to operating a factory, and without a factory the farmer has no market for his beets. He could only use them as a food for stock. So we will consider some of the necessary factory conditions.

QUALITY OF BEETS.

One of the first things that every factory will consider is the quality of beets grown in the locality that must supply the factory. As has been observed, the effectiveness of the process, the quality of the finished product, and the expense of operating the factory depend largely upon this point. The more impurities, or such elements as are recognized as impurities, contained in the beet, the more difficulties there are in extracting the sugar. It should therefore be the aim of everyone investing in a factory for the production of beet sugar in this country to require the best conditions in the matter of purity of beets as well as a tonnage that is remunerative and profitable both to the manufacturer and the farmer. It is along this line that the Department of Agriculture and the agricultural experiment stations in the several States are working industriously and earnestly in order to be able to offer reliable information to all concerned.

PURE WATER.

A factory requires large water facilities. For a factory having a capacity of 350 tons of sugar per day (which is considered about the minimum in this country for a factory working under favorable conditions) there should be a permanent supply of about 2,000,000 gallons of pure water a day. In the first place, water is used as a medium of conveyance for bringing the beets from the beet sheds, which in many cases are several hundred feet away from the factory. These sheds are connected with the factory by canals about 1½ feet wide and 2 feet deep. The bottoms of the sheds are arranged on an inclined plane, so as to allow the beets to slide into the canal as they are needed. In some instances the beets are shoved into the canal by workmen. Sufficient water must be allowed to flow through these canals to flood beets and to carry them to the receptacles in the factory arranged for receiving and washing them. The water performing the service of transporting the beets is permitted to pass through a grating into the sewer. Water is also extensively used all through the factory for steam power and other operations of the machinery and in the process of manufacture, and, since the work of the factory is largely for the purpose of eliminating impurities in the beets, the water used in these processes must be of such quality as will not increase these impurities, and thus add to the difficulties of the manufacturer. (See under "Lime and water for beet-sugar factory purposes," pp. 205–207.)

FUEL.

Fuel is another item that should be carefully considered as one of the conditions necessary in establishing a beet-sugar factory. In manufacturing a ton of beets into sugar about 2 or 3 per cent of coke is required and 13 to 15 per cent of coal. The coke is required for burning the limestone, and it may be used for producing carbonic-acid gas,

which is obtained by the combustion of coke and charcoal in ovens specially prepared for the purpose. It will readily be seen that fuel is a factor that is closely related to the matter of economy in a factory, since it is one of the heavy items of expense. In California crude petroleum is used to a large extent for fuel. This oil is found in the southern part of the State, and its use compares favorably, so far as economy is concerned, with coal in the districts where the latter is mined. As fuel, it is well adapted to the factory work. It is cleaner and requires less labor to handle it. In these respects it makes up largely for what it lacks in cheapness. It has been claimed by some sections that in heavily wooded districts cheap wood can be used to advantage. We are not prepared to state as to the desirability of wood for fuel in this connection, but it would be well for those entertaining this view of the subject to investigate it thoroughly. The price of coke in the districts already manufacturing beet sugar, or beginning the work preliminary to doing so, ranges between $4 and $13. Some of the districts can supply coal to the factory of sufficient quality for the purpose at 75 cents to $1.25 per ton, and it costs in other districts already manufacturing, or intending to do so, from $3 to $4 per ton. These differences in prices of fuel, when considered in connection with other items of expense that enter into factory work, will be strong factors in the manufacture of beet sugar further along in the history of the industry in deciding the contest when competition becomes active. It should be the aim of every locality to study fully these points.

LIMESTONE.

It has been noticed before that the factory is a large consumer of limestone. This stone is burned in the factory in a specially arranged kiln. It is well understood that in the process of burning limestone carbonic-acid gas is driven off, and the object of burning the lime in the factory, instead of buying the prepared lime, is for the purpose of securing this carbonic-acid gas, which is used in the process of manufacturing the beet sugar as well as the burned lime. The burned lime is put into the juice, either in a powdered state or as milk of lime, as the first process after the juice has been sufficiently warmed. The object of this is to have the lime unite with the impurities in the juice both chemically and mechanically, and then by injecting the carbonic-acid gas, by bubbling it through the limed juice, a union of calcium and the carbonic-acid gas is effected. This forms calcium-carbonate, the substance originally started with in the limestone before burning. This carbonic acid gas, it will be remembered, was secured by burning limestone and then collected, after having been driven off, for the purpose stated. In this process is seen the nice adaptation and application of the principles of science, by which the crude stone is separated into its elements, one part placed in the juice of the beet to perform a certain function and another part injected again, and after uniting the two in the process forming the original substance, which holds in its grasp

the impurities that were contained in the beets. The whole is then removed from the juice by forcing the juice, under high pressure, through a very finely woven cloth called a filter. Now that we know the use for which this lime is required, the suggestion naturally follows that this limestone should be pure. It should not contain any of the elements which the sugar maker believes to be deleterious to the quality of his product. It should be a pure limestone, and since it is extensively used, it should be a cheap stone, and one that could be obtained near at hand. It is therefore necessary, in studying the conditions of a locality with a view to establishing therein a factory, that we should consider very carefully the quality and cheapness of its limestone as well as its supply. (See under "Lime and water for beet-sugar factory purposes," pp. 205–207.)

MARKETS.

It naturally follows in any factory enterprise that a market is one of the conditions necessary to its success. In investigating the conditions necessary for establishing a factory it is requisite to have fully in mind its accessibility to trade centers; also whether the transportation facilities are sufficient to permit it to compete with other localities more especially favored in these respects. We might mention as sections having ideal conditions of this kind the lower peninsula of Michigan, which has shown good conditions for raising beets and a disposition of the people to embark in the enterprise. The finished product in the factories here would be available for some of the best trade centers in the country, such as Detroit, Milwaukee, Chicago, etc., and it would have the benefit of transportation by water through the Great Lakes as well as by the network of railroads which extend in every direction. These insure cheap freight and offer facilities for shipping the product to market quickly. What is said of this locality might be equally true of Indiana, New York, and other localities having similar conditions. Localities taking upon themselves the responsibility of maintaining factories should study these facilities under the best conditions, because these are the questions that will meet them in competition on the market.

ORIGINAL COST.

It requires considerable money to build a factory, and as the original cost of improvements is the larger portion of the investment, we must include in our estimates of the cost of production the interest upon the money so tied up. The cost of building materials is also an item that demands careful consideration. It is one, however, upon which it is easy to make comparisons.

PERMANENT AGRICULTURAL CONDITIONS.

One must make a thorough investigation as to the general agricultural conditions of a locality when considering the establishment of a factory. It will be impossible to raise sugar beets continuously on the

same tract of land, as is the case with other crops, and a locality is best suited to raising sugar beets as a permanent enterprise that can secure a series of rotation of crops. We have in mind a locality that is now raising sugar beets extensively for the factory that can not, it is claimed, successfully raise anything else, and experience is evidently showing, what all good agriculturists would predict, that the farmer there will come to grief before long. If something is not found to rotate with the sugar beet, where the sugar beet alone is grown, the result will be a lessening of the tonnage and purity of the beet. In considering the successful growing of sugar beets, we include not only the conditions that insure the permanency of the enterprise, but such a well-balanced series of rotation of crops as will readily restore the soil to its productiveness and make the permanency of the sugar beet possible. In the case of the sugar beet a large part of the work of its cultivation can not be accomplished by the aid of machinery. For instance, when the plants have reached the point that is called "putting out the fourth leaf," the beets must be "bunched and thinned." It will be recalled that the farmer is asked to sow from 15 to 20 pounds of seed per acre; 3 or 4 pounds would do the work, however, if he was absolutely sure that all the seed would grow. This larger number of pounds is used in order to be sure of a "stand," because a "stand" he must have. This places the beet seed in rows close to each other, say, touching each other, and it can be readily observed that all of the beets must not be allowed to grow. It therefore becomes necessary to "thin out." This has been described under "Thinning and bunching," p. 190.

The success of the crop after the bunching and thinning depends largely upon the thoroughness of cultivation—careful hoeing and weeding. The field must be kept clean and free from weeds, not only with the cultivator, but with the hoe and hand. So that another condition that affects the permanency of beet farming in a community is its ability to furnish the necessary labor. Large cities and towns are usually depended on for labor of this kind. Boys and girls, from 12 to 16 years of age, on account of their suppleness and nimbleness, are employed for this purpose in many sections, and seem to stand the wear of the labor better than adults. It requires all the fortitude of a community in establishing a beet-sugar factory to meet the first shock when the revelation of the amount of labor to be performed in raising the beets first dawns upon them; it is so out of proportion with what is usually necessary in growing other crops. We do not wish to be understood as trying to unduly alarm any one in this direction, but think it is but fair that sufficient emphasis should be put upon the point in question, in order that it may be fully understood before such responsibilities are assumed. If we were to write the history of the beet-sugar enterprise in the United States, a large part would be devoted to a statement of the vexing and trying experiences of the manufacturer and the farmer in arriving at a solution of this labor problem. But our factories now in operation have met the difficulties,

and through experience our farmers have learned what is required in growing this crop. They have also learned that they can receive enough money for the crop to employ sufficient labor to do the work, pay all other expenses, and still have a handsome profit.

Lime and Water for Beet-sugar Factory Purposes.

We have often been asked by organizations and others interested in the beet-sugar industry, desiring to investigate closely the facilities and resources for this purpose, "What constitutes a good limestone and good water for beet-sugar factory purposes?" For the purpose of answering this question we quote the following papers from "A handbook for chemists of beet-sugar houses and seed-culture farms," prepared by Guilford L. Spencer, D. Sc., of the United States Department of Agriculture:

SALTS IN SOLUTION AND THEIR EFFECT IN WATER USED IN SUGAR MANUFACTURE.

The condensation waters from the multiple effects, vacuum pans, etc., form an abundant and very satisfactory supply of water for the boilers.

The water for the diffusion battery should be as pure as possible and should contain a minimum amount of calcium and magnesium salts and of the salts mentioned below as melassigenic. The calcium and magnesium salts, notably the bicarbonates and the sulphate of calcium, foul the heating surface of the battery and evaporating apparatus. The bicarbonates decompose to some extent in the diffusers and deposit the normal carbonates upon the cossettes and probably influence the diffusion unfavorably. The water should not contain more than 10 parts per 100,000 of calcium sulphate, otherwise incrustations may form at some stage of the concentration of the liquors.

Pure water should also be used in slacking the lime, though for economy of sugar and in the evaporation certain wash waters containing sugar, etc., are used for this purpose.

The most important melassigenic salts are sulphates, alkaline carbonates, and nitrates. The chlorides are rather indifferent as regards the formation of molasses.

SUGGESTIONS ON THE DESIRABLE AND UNDESIRABLE COMPOSITION OF LIMESTONE USED IN SUGAR MANUFACTURE.

The difficulties usually encountered in the management of the limekiln are as follows: A limestone containing too much silica will show a tendency to fuse, and if overheated will adhere firmly to the walls of kiln. Stone in too small pieces, or stone and coke not properly distributed, or stone with an excess of coke, will sometimes "scaffold," or bridge. The above conditions soon prevent the downward progress of the stone and lime. These difficulties are obviated by the use of suitable stone, properly mixed with the coke and evenly distributed in the kiln, and by the withdrawal of lime at regular intervals. Should the charge "scaffold" in the kiln, it can only be broken down by the withdrawal of a considerable quantity of material at the lime doors and energetic use of an iron bar at the "peep-holes." The use of too little coke or the too rapid withdrawal of lime results in an undue proportion of underburned or raw lime. The admission of too little air to the kiln results in an imperfect combustion and an excess of carbonic oxide in the gas. This carbonic oxide not only is a loss of carbon, but, if carelessly inhaled by the workmen, may result in serious poisoning. The addition of too much air dilutes the gas. This latter may result from leakage in the pipes, careless charging, or from driving the gas pump too fast. The following table contains valuable information relative to the quality of the limestone.

Analyses of limestones and comments[1] on their composition.

[Messrs. Gallois and Dupont, Paris.]

Substance.	1	2	3	4	5	6	7	8	9	10
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Moisture	4.10	5.10	7.25	4.15	4.17	6.25	5.16	0.52	1.21	0.11
Sand, clay, and insoluble matter	4.50	5.15	4.90	2.15	3.07	3.17	2.25	2.85	.55	.27
Organic matter	1.20	1.17	1.37	1.05	.97	1.12	.86	.30	.41	.15
Soluble silica	2.10	1.75	3.30	1.05	.98	.64	.56	.06	.20	.03
Oxides of iron and alumina (Fe_2O_3, Al_2O_3)	.37	.41	.27	.17	.19	.15	.20	.32	.23	.....
Carbonate of calcium ($CaCO_3$)	85.86	85.12	81.67	90.13	88.65	87.93	90.03	93.80	96.58	99.10
Carbonate of magnesium ($MgCO_3$)	.95	.47	.59	.75	.95	.50	.45	1.81	.50	.....
Sodium and potassium (Na_2O, K_2O)	.05	.06	.....	.10	.01	.....	.....	.....	.....	.....
Undetermined	.87	.77	.65	.45	1.00	.24	.39	.34	.32	.34
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Nos. 1, 2, 3, and 4 are bad, Nos. 5, 6, and 7 are passable, and Nos. 8, 9, and 10 are excellent.

Limestone No. 3 was used in a sugar house, and caused much trouble, notably, "scaffolding," difficulty in the mechanical filtration, incrustations in the triple effect and on the vacuum-pan coils. No. 9 was substituted for this stone, and these difficulties disappeared.

In the examination of a limestone, its physical condition as well as its chemical composition must be taken into account. The stone should be compact and hard, thus reducing the quantity of fragments and the risk of "scaffolding" in the kiln.

Excessive moisture, 5 per cent or more, in the stone reduces the temperature of the kiln when charging, involving an imperfect combustion and the production of carbonic oxide (CO); further, such stones break into small pieces under the influence of the heat. A small proportion of water, approximately 1 per cent, probably facilitates the decomposition of the stone, and is advantageous.

Magnesium is not objectionable, so far as the operation of the kiln is concerned, except in the presence of silicates, but it introduces difficulties in the purification of the juice and forms incrustations on the heating surfaces of the evaporating apparatus. It forms fusible silicates at high temperatures, and thus increases the tendency to "scaffolding." The objections to the sulphate of calcium are practically the same as to magnesium.

The objections to the presence of silicates are, as indicated above, in the formation of fusible silicates of lime and magnesium. Part of the silica passes into the juice with the lime, retards the filtration with the presses, and coats the cloth of the mechanical filters, to their detriment. Silica also forms part of the scale on the heating surface. Less harm results from this substance in hard limestones than from that in soft stone; hence, if the stone be hard and compact, a larger content of silica is admissible than in a soft stone.

When necessarily using stone of comparatively poor quality, the best obtainable coke should be employed.

MELASSIGENIC SALTS.

The following salts are positive molasses makers, that is, salts which promote the formation of molasses:[2] Carbonate, acetate, butyrate, and citrate of potassium.

The following have no influence on the formation of molasses and are classified as indifferent: Sulphate, nitrate and chloride of potassium, carbonate and chloride of sodium, calcium hydrate, valerate, oxalate and succinate of potassium and oxalate, citrate, and aspartate of sodium.

[1] Mr. Cutler, manager of the Lehi factory, Utah, says: "We would regard as a good quality of limestone one containing from 95 to 98 per cent of carbonate of lime and not more than one-half to 1 per cent of silica."

[2] This is to be avoided, because the more molasses the less sugar.

The negative molasses makers, that is, salts which promote the crystallization of sucrose, are sulphate, nitrate, acetate, butyrate, valerate, and succinate of sodium, sulphate, chloride, and nitrate of magnesium, the chloride and nitrate of calcium, and the aspartate of potassium.

LIME ROCKS AND WATERS USED IN THE MANUFACTURE OF BEET SUGAR.

The following paper on the lime rocks and water used in the manufacture of beet sugar is by Mr. G. S. Dyer, superintendent of the beet-sugar factory at Los Alamitos, Cal.:

I give below the analysis of three types of rock:

Constituents.	Good (Colton).	Passable (Oro Grande).	Bad (A French).
	Per cent.	*Per cent.*	*Per cent.*
Calcium carbonate	98.000	94.306	81.67
Magnesium carbonate	.453	1.845	2.50
Iron and alumina	1.096	.929	.27
Silica, sand, etc	.281	.900	8.20
Moisture	.054	.038	5.25
Organic matter and $MgSO_4$	.....	.701	1.37
Undetermined	.116	1.281	.64
	100.000	100.000	100.00

Moisture is the first important point, as it takes just that much more coke to drive it off, and, besides, it causes the breaking of the rock while undergoing cooking, also the resulting dust helps to cause the massing of the kiln. Hard rocks contain but little water, but soft ones may contain as high as 20 per cent. Hygroscopic rock should be sheltered from the rain. If possible, do not use rock that contains more than 2 per cent of moisture.

Silica and aluminum present great inconveniences, inasmuch as these two substances form silicates and aluminates of calcium and magnesium during calcination, causing an insoluble coat to form on the outsides of the lime lumps that prevent it from slacking readily. The silica that enters the juice is broken up by the action of the alkalies and is precipitated on the tubes of the evaporators. Magnesium is not particularly harmful in quantities not to exceed 3 per cent; if more, it silicates in the burning, and if abundant causes a false alkalinity of the juice besides incrustations on the tubes of the evaporators and vacuum pan. Calcium sulphate presents the same faults as magnesium, and proportionately lowers the saline coefficient of the product, thereby hindering the crystallization of sugar. It is well also to avoid a rock that decrepitates badly during calcination. A great many times the rocks can be mixed to good advantage—hard and soft.

What has been said about the individual composition of the lime rocks can be applied to the water as well. It is needless to say that the purer the water the better. The water used at Alvarado has 22.5 grains per gallon; Lehi, 21; Eddy, N. Mex., 17.2, and Los Alamitos, 20. Just what the extreme limit would be I am not prepared to state, probably in the vicinity of 35 or 40. The mineral matter taken into the juice in this manner amounts to considerable when one stops to think that an ordinary factory uses about 200,000 gallons in twenty-four hours.

By using condensed water from the evaporators the troublesome scale in the boilers is very much improved, and at this particular plant this scale, which formed for the whole season of one hundred days, was not of the thickness of ordinary note paper.

Answers of Factory Officials to Questions Relative to Factory Work.

During the investigations of the past year certain questions were propounded to the superintendents, managers, and experts of the beet-sugar factories with the view of gaining information touching the mechanical and practical problems incident to the factory side of the beet-sugar industry. The public generally is not so much interested in the particular person as it is in the fact that the answer was made by one thoroughly experienced in the operation of a factory; hence, the official answering is given after each answer, which is therefore worthy of consideration as coming from good authority. The number of each answer refers to the order in which the factory was visited.

The questions and answers are as follows:

What do you pay farmers for the sugar beets?

(1) We pay $4.25 per ton for beets, and we pay a part of the freight, which brings the price of the beets up to something like $4.50.—(Superintendent.)

(2) We pay $4 per ton for beets. When we receive a bounty we pay $5 per ton.—(Assistant superintendent.)

(3) We pay $4 per ton for beets.—(Superintendent.)

(4) We pay $4.50 per ton.—(Superintendent.)

(5) We pay $3.50 per ton for beets showing 12 per cent sugar content and 80 per cent purity.—(Manager.)

(6) We pay $4.50 per ton for beets as they run.—(Manager.)

How much does the recent improvement in machinery reduce the cost of making sugar?

(1) Saves cost and time.—(Superintendent.)

(2) We are making sugar cheaper than ever.—(Assistant superintendent.)

(3) Quite materially.—(Superintendent.)

What would be a fair estimate of the cost to the farmer for raising the beets and delivering them to the factory?

(1) I would say that the average cost to the farmer for raising and delivering a ton of beets would be ordinarily, with a good crop, from $2.50 to $3 per ton.—(Superintendent.)

(2) It will cost the farmer from $25 to $30 an acre.—(Assistant superintendent.)

(3) It will cost from $23 to $30 per acre.—(Superintendent.)

(4) It costs our farmers about $23 an acre.—(Superintendent.)

(5) It will cost our farmers from $20 to $25 to produce and deliver an acre of beets.—(Manager.)

(6) It will cost the farmers here from $25 to $35 to produce and deliver an acre of beets.—(Manager.)

What is the average rent that farmers have to pay for sugar-beet land?

(1) The rental per acre for good sugar-beet land in this vicinity is from $10 to $15 per acre.—(Superintendent.)

(2) The farmers usually give from one-fourth to one-fifth of the crop.—(Assistant superintendent.)

(3) The rent is usually from $15 to $20 per acre. In some places, however, it is as low as $4 per acre.—(Superintendent.)

(4) The farmer usually gives one-fourth of the crop delivered, which would mean usually $9 to $12 rent per acre.—(Superintendent.)

(5) Our farmers give from one-fifth to one-fourth of the crop. Very little land is rented on the basis of so much per acre cash rent.—(Manager.)

(6) The land is largely owned by a company, and they sell the land to the farmer, who raises his own beets. The company either hires its own beets raised on the rest of the land, or if it rents receives one-fourth of the crop.—(Manager.)

[NOTE.—In Nebraska good sugar-beet land rents at from $4 to $6 per acre.—C. F. S.]

What do you do with the pulp?

(1) We have a large creamery here that uses considerable of the pulp and the farmers are beginning to use it quite extensively. The pulp is fed to cattle and sheep. The cattle readily eat about 100 pounds of pulp per day and 15 pounds of hay, the sheep eating in proportion. They make excellent beef and fatten in a short time; the meat is much sought after at home and in Eastern markets.—(Superintendent.)

(2) Sell one-half for 10 cents per ton to cattle company and some to farmers. The latter demand is increasing rapidly. The remainder is disposed of as waste.—(Assistant superintendent.)

(3) Give it away mostly and sell some of it. Most of it is used by the farmers; they are trying it.—(Superintendent.)

(4) Some of our pulp is hauled away as it is produced; some we are siloing and arranging stock yards where it will be used in feeding. Some dairies are using the pulp and the demand from farmers is growing stronger. We sell it to-day at 50 cents per ton.—(Superintendent.)

(5) Our pulp is contracted for by another company, which sells it to cattlemen; 1,500 to 3,000 head of cattle are fed here. The creameries are using some. The farmers are using very little. All of our pulp is consumed in this way. It is better feed after standing for a while.—(Manager.)

(6) We fed our pulp last year to cattle. This is a great cattle country and we will dispose of all of our pulp in this way.—(Manager.)

What do you do with the molasses?

(1) We do nothing with the low-product molasses, but we have now contracted to sell it to a company for from 1 to 1½ cents per gallon to be used in the manufacture of alcohol.—(Superintendent.)

(2) Nothing.—(Assistant superintendent.)

(3) Nothing.—(Superintendent.)

(4) We use the "crystallization-in-motion process," and aim to extract as much sugar from the molasses as possible. After the purity drops below 60 we throw it away.—(Superintendent.)

(5) We use the Steffens process in the manufacture of sugar. We have a special department in the factory for working up the low-product molasses, and through this process we are enabled to extract most of the sugar.—(Manager.)

(6) The low-product molasses is thrown away. It contains from 50 to 53 per cent of sugar.—(Manager.)

What is the cost of making beet sugar ready for the market?

(1) It would be very difficult to give you the data as to making a ton of sugar in this country as yet. In 1896 we worked 43,000 tons of beets, making therefrom 9,156,000 pounds of sugar, the cost of which was $3.71 per 100 pounds.—(Superintendent.)

[NOTE.—This would be about $74.20 per ton.]

(2) About 3 cents per pound.—(Assistant superintendent.)

(3) About $70 per ton or 3 to 3½ cents per pound.—(Superintendent.)

(4) Seventy dollars per ton or 3 to 3½ cents per pound.—(Superintendent.)

(5) Three to 3½ cents per pound.—(Manager.)

(6) The cost of making sugar varies from $2.25 to $2.75 per ton of beets, not figuring the cost of the beets.—(Manager.)

What kind of beet seed does best in your locality?

(1) We have found the seed best adapted to our locality is the Kleinwanzlebener. We have also had good success with home-grown seed.—(Superintendent.)

(2) We found the Vilmorin and the improved Kleinwanzlebener do best.—(Assistant superintendent.)

(3) Vilmorin and its derivations seem to be better for arid climates.—(Superintendent.)

(4) We succeed better with the original Kleinwanzlebener and improved Vilmorin.

(6) We have had good luck with Kleinwanzlebener and improved Kleinwanzlebener. We find the home-grown seed grow splendidly.

What per cent of your machinery is American made and what per cent is American design?

(1) Nearly all our machinery is American made and American design.—(Superintendent.)

(2) Twenty per cent is American made and design.—(Assistant superintendent.)

(3) Ninety-nine and one-half per cent of our machinery is American made and all of it modified to suit our improved conditions.—(Superintendent.)

(4) Nearly 100 per cent of our machinery is American made and design.—(Superintendent.)

(5) Orignally all of our machinery was of German make, but now 50 and 66⅔ per cent is American made and design.—(Manager.)

(6) We secured our machinery originally by purchasing a factory in Canada of French design and make. Our improvements are generally of American design and make.—(Manager.)

When do your farmers plant beet seed?

(1) The seed is planted here in April or fore part of May. The amount of rainfall that we have from time of planting until the time of harvesting is very small as a rule. We therefore irrigate the beets, and they require watering from two to five times during the season.—(Superintendent.)

(2) From February to June. We draw our beets from several valleys with different climates, which causes the difference in time of planting and harvesting.—(Assistant superintendent.)

(3) Should plant in the middle of March, but the bulk is planted in April and some as late as June.—(Superintendent.)

(4) We plant from March 1 to April 30; sometimes we can plant in February if it turns warm enough. We have planted in September and had 18 per cent of sugar in the beets and good purity.—(Superintendent.)

(5) We plant from February to June, according to the locality and the season.—(Manager.)

(6) That is the problem. We are new. Early planting did the best; this year we planted as late as the middle of June. We feel that it is best to plant in February and March for our season, or wait for the usual rain in May and June, our second season.—(Manager.)

When do your farmers harvest?

(1) We begin harvesting the last of September.—(Superintendent.)

(2) August 15 to January 1; sometimes we finish in December and sometimes in March.—(Assistant superintendent.)

(3) From the middle of August to the last of November, according to season and locality.—(Superintendent.)

(4) We can harvest from July 5 to end of campaign, about November 1.—(Superintendent.)

(5) We harvest from July to November 15, according to the locality.—(Manager.)

(6) Harvesting is done here from the middle of October to the middle of November.—(Manager.)

How do your farmers care for the beets until they are worked by the factory?

(2) Leave them in the ground.—(Assistant superintendent.)

(3) Leave them in the ground until we call for them and put the balance that is left in November in the sheds.—(Superintendent.)

(4) Leave them in the ground and harvest them as needed.—(Superintendent.)

(5) The beets are left in the ground until they are called for by the factory when

our fall runs begin in November. After this some of the beets may still be unworked. These beets will have to be siloed; not many have to be treated in this way, however.—(Manager.)

(6) We aim to keep about 1,000 tons of beets in the sheds. The farmers leave the balance of the beets in the ground until called for.

How do you buy your seed?

We buy early in the fall of a good, safe firm, either in Europe or through their agent here.—(Assistant superintendent.)

(3) We buy our seeds in Austria, Germany, and Russia about the 15th of September, and have them shipped right along in original packages, of standard firms having established reputations.—(Superintendent.)

(4) We buy of best European firms through their American agent. We buy in September.—(Superintendent.)

(5) We buy from best houses in Europe and have the seeds tested when they arrive.—(Manager.)

(6) We buy original Kleinwanzlebener of the agent who represents that firm in this country.—(Manager.)

What fuel do you use; where is it from; and what does it cost?

(1) We use coal for fuel. It cost us last year $3 per ton delivered; and it is derived from a point in our State about 70 miles from the factory. It requires about .13 per cent of coal to 1 ton of beets.—(Superintendent)

(2) We use crude petroleum. Our supply comes from Los Angeles, Cal. It costs about $1.05 per barrel f. o. b. there.—(Assistant superintendent)

(3) We use lignite coal from England. It cost $6.30 per ton.—(Superintendent.)

(4) We burn crude petroleum. We get our supply from Los Angeles, Cal. Its cost is about equal to steam coal at $3 per ton.—(Superintendent.)

(5) We use petroleum. Our source of supply is near the factory. About four barrels of oil is equal to 1 ton of coal.—(Manager.)

(6) We use bituminous coal. Our source of supplies is about 400 miles away. It costs us $3.35 per ton. The cost at the mine is 90 cents.

What does coke cost your factory?

(1) Our coke costs us $11 per ton delivered. We only use 2 per cent of it to 1 ton of beets.—(Superintendent.)

(2) We get our supply of coke from Wales. It costs us about $12 per ton.—(Assistant superintendent.)

(3) We got our supply of coke from England. It costs from $7 to $8.—(Superintendent.)

(4) Our coke costs about $11 per ton.—(Superintendent.)

(5) We use coke from England. It costs us $13 per ton.—(Manager.)

(6) We use coke from Pennsylvania. It costs $10.35 per ton.—(Manager.)

From whence do you secure your supply of limestone and what does it cost you per ton?

(1) Limestone costs us about $2 per ton delivered and broken up to the size that we require. This we get from a quarry about 16 miles distant, and it is hauled to the factory by teams, as there are no railroads. We require about 6 per cent of lime to a ton of beets. We require a good quality of limestone, one containing 95 to 98 per cent of lime and not more than one-half to 1 per cent of silica.—(Superintendent.)

(2) Our limestone costs us from $1 to $1.25 per ton.—(Assistant superintendent.)

(3) Our limestone costs us about $1.50 per ton. We have to ship it about 60 miles.—(Superintendent.)

(4) Our source of supply of limestone is about 90 miles from the factory. We pay $2.50 per ton.—(Superintendent.)

(5) Our source of supply is about 90 miles distant.—(Manager.)

(6) Our limestone comes about 12 miles. It costs $1.80 per ton.—(Manager.)

How many tons of beet are required to make a ton of white granulated sugar?

(1) It would be difficult to give you any accurate data as to the cost of making a

ton of beet sugar in this country as yet. In our locality last year the average tonnage was 14 per acre. The average sugar in the beets was 13.9 per cent, with 82.5 purity. With such beets we obtain nearly 210 pounds of sugar from a ton of beets. In 1896 we made our sugar run about a ton to 9½ tons of beets.—(Superintendent.)

(2) We secure about 13 per cent of raw sugar and 8 to 9 per cent of refined sugar from a ton of beets.—(Assistant superintendent.)

(3) We require about 10½ tons of beets to make a ton of white granulated sugar.—(Superintendent.)

(4) You can extract about 75 to 80 per cent of the sugar in the beet. Of course, if the beet shows an average of 15 per cent sugar, such as ours will, this would be 12 per cent of the actual tonnage of beets worked.—(Superintendent.)

(5) Under our process, which is to get as much sugar out of the molasses as possible, we lose about 3½ to 4½ per cent of the original sugar in the beet, and in case the average be 15 per cent sugar in the beet the amount of sugar that could be extracted would be equal to 15 minus 3½ or 4½.—(Manager.)

(6) There is a loss of about 3.65 per cent of the original sugar in the beet. Subtracting this from the average amount of sugar in the beet originally you will have the amount of sugar that can be extracted.—(Manager.)

How much pulp is left after working a ton of beets?

(1) About 50 per cent of dry-pressed pulp will result from a ton of beets.—(Superintendent.)

(2) We generally have about 40 per cent of pulp of the original tonnage of beets.—(Assistant superintendent.)

(3) That depends on the amount of pressure applied in forcing out the water, but it will usually run about 38 per cent of the original tonnage of beets.—(Superintendent.)

(4) We have left about 46 per cent in pulp of the original weight of beets.—(Superintendent.)

(5) Our pulp runs about 50 to 55 per cent of the original weight of the beets.—(Manager.)

What experiments have you tried with pulp and molasses?

(1) There has been a local company organized here to buy the low product molasses, from which they will make alcohol. They pay us from 1 to 1½ cents per gallon for the molasses.

(3) There is an alcohol process for extracting the sugar in the molasses. If we could use this process we could get practically all of the sugar out of the molasses, but in doing so we would have to recover our alcohol after each process, so that in doing this we would come in contact with the United States revenue laws. Therefore it is not used.—(Superintendent.)

(4) We have tried no experiments with either pulp or molasses.—(Superintendent.)

Observations Growing Out of Answers to Questions Submitted to Factory Operators.

COST OF FACTORIES.

There is a general inquiry in localities where the question of establishing a beet-sugar factory is being agitated as to the cost of constructing and equipping a factory. The cost of a factory will vary in different localities, depending upon the local cost of building materials, the freight rates for shipping these materials, and the cost of freight on machinery, etc. There is a general rule, however, that appears to be accepted as a fair estimate by those best informed in beet-sugar factory construction, namely, that it will cost $1,000 per ton of daily capacity to construct and equip a factory of 300 tons per day

or over. Factories having capacities of less than 300 tons per day will cost more than $1,000 per ton, and it is to be presumed that for a factory of considerably more than 300 tons capacity per day the cost of construction would be materially less than $1,000 per ton. According to the rule mentioned, however, the estimate must be $300,000 to construct and equip a factory of 300 tons capacity per day, $500,000 for one with a capacity of 500 tons per day, etc. We have before us an estimate by a gentleman thoroughly familiar with the construction of beet-sugar factories. These estimates give considerable details in the matter of construction and will be especially valuable in suggesting items that must be considered by people in a locality where the question of constructing a factory is being considered. The first estimate is for a factory of 300 tons capacity per day, and the second is for a factory with a capacity of 500 tons per day. Each estimate is based on one hundred days as the length of the "campaign," or the time the factory will be engaged in working the beets for the year.

ESTIMATE OF A BEET-SUGAR FACTORY OF 300 TONS CAPACITY PER DAY.

In presenting these estimates for your consideration we beg to call your attention to the following points, to wit:

Our figures are based on first-class brick buildings, constructed as nearly fireproof as possible, also brick smokestack and A1 boilers.

We include in our estimate large beet sheds, sugar storehouse, limekilns, office, and laboratory, including outfit.

We figured on the latest improved, most modern, and labor-saving machinery and apparatus, either foreign or American manufacture, to make white granulated sugar direct from the beets without refining, and have also included in our estimate a process for the working up of all afterproducts during the campaign, which latter arrangement is quite an item of cost.

The whole plant to be of the very best and latest design and workmanship, and so constructed that its capacity can be easily enlarged at the minimum cost and for the special purpose of saving every possible item of labor and expense.

Our estimates, although very conservatively made, are to be taken approximately, because correct estimates of the cost of a plant, of expenses, and profits vary so widely with varying conditions in the different States (as to cost of fuel, labor. material, beets, etc.) that it is impossible to submit here a more detailed estimate, We may add that we figured on a campaign of one hundred days and one hundred nights and based the amount of product and profit on 12.7 per cent yield of the weight of the beets, which is the general average yield of sugar beets in America.

Estimate of cost, running expenses, and profits of a beet-sugar factory of capacity of 300 tons of beets per day of twenty-four hours.

Total capital needed, not including cost of land for factory and additional buildings, which site should be 15 to 20 acres, to be about	$315,000
Running capital:	
The capital required to operate the factory to be	30,000

Usually the bills for fuel, lime, and other materials and work are paid at the end of every month, and it is the same with farmers in regard to payment for their beets. Sugar, as one of the most required staple articles, is sold for cash or on short time, and every day 38.10 tons, or 76,200 pounds, of sugar will be ready for sale. The company should at the end of each month have sufficient money collected from their sales not only to meet all payments, but have a good surplus. For this purpose the sum of $30,000 will be sufficient.

Cost of plant:		
For all factory buildings, sugar storehouse, beet sheds, office and laboratory, limekilns, foundation for engines and apparatus, including all other mechanical work		$95,000
For boilers, engines, pumps, machinery, and millwright work; also for the entire inside outfit and apparatus of either American or foreign manufacture		190,000
Cost of plant complete		285,000
Salaries and general expenses:		
Technical superintendent	$5,000	
General manager	3,000	
Agricultural expert	2,000	
2 chemists during "campaign"	1,000	
Head machinery engineer and assistant	2,300	
2 sugar boilers, at $250 each	500	
2 overseers, at $800 each	1,600	
Weighmaster	800	
Bookkeepers, clerks, typewriter, and other office help	4,000	
Stationery, advertising, and incidentals	1,000	
Expenses of meetings of the board of directors	1,200	
Selling expenses of sugar to jobber	5,000	
Insurance, 1½ per cent of $150,000	2,250	
Repairs on machinery per campaign	3,000	
Depreciation, 7 per cent on $200,000 machinery	14,000	
6 per cent interest on $315,000 capital invested	18,900	
Salaries and general expenses		65,550
Wages for labor:		
20 skilled laborers, 100 days and 100 nights, 12 hours per day, or together 4,000 days' work, at $2.50	10,000	
40 common laborers, 100 days and 100 nights, or together 8,000 days' work, at $1.75	14,000	
Total wages		24,000
Running expenses:		
4,500 tons of coal (slack), equal to 15 per cent of weight of beets, at $1.50	6,750	
Limestone and coke	7,040	
Oil, etc	860	
Reserve materials	2,000	
Linen for filter presses	1,400	
Electric light	1,200	
Sacks	1,400	
30,000 tons of beets, at $4 per ton	120,000	
Total for running expenses		140,650
Total salaries, wages, and all expenses		230,200
Product and return for same:		
The general average yield of sugar in America has been 11 per cent of the weight of the beets; taking this as a basis and the present price of sugar at $92 per ton, the total production from 30,000 tons of granulated sugar, at $92 per ton		303,600
For pulp at 25 cents per ton, say for campaign, 6,000 tons		1,500

Margin on seed, 3 cents per pound, on 60,000 pounds	$1,800
Total returns	306,900
Total expenses	230,200
Net profits	76,700

[NOTE.—Cost of coal, lime, labor, and other materials may be cheaper in your locality than figured in above investment; and if this is the case, the expenses will be less and the cost of producing sugar cheaper.]

Estimate of cost, running expenses, and profits of a beet-sugar factory of capacity of 500 tons of beets per day of twenty-four hours.

Total capital needed, not including cost of land for factory and additional buildings, which site should be 15 to 20 acres large, to be about	$425,000
Running capital:	
The capital required to operate the factory to be	50,000

Usually the bills for fuel, lime, and other material and work are paid at the end of every month, and it is the same with farmers in regard to payment for their beets. Sugar, as one of the most required staple articles, is sold for cash or on short time. Every day 63.5 tons, or 127,000 pounds, of sugar will be ready for sale. The company should at the end of each month have sufficient money collected from their sales not only to meet all payments but have a good surplus. For this reason the sum of $50,000 will be sufficient.

Cost of plant:	
For all factory buildings, sugar storehouses, beet sheds, office and laboratory, limekilns, foundations for engines and apparatus, including all other mechanical work	125,000
For boilers, engines, pumps, machinery, and millwright work; also for the entire inside outfit and apparatus of either American or foreign manufacture	250,000
Cost of plant complete	375,000

Salaries and general expenses:		
Technical superintendent	$5,000	
General manager	3,000	
Agricultural expert	2,000	
Two chemists during campaign	1,000	
Head machinery engineer and assistant	2,300	
2 sugar boilers, at $250 each	500	
2 overseers, each $800	1,600	
Weighmaster	800	
Bookkeepers, clerks, typewriter, and other office help	5,000	
Stationery, advertising, and incidentals	1,000	
Expense of meeting of board of directors	1,200	
Selling expenses of sugar to jobbers	8,000	
Insurance, 1½ per cent of $200,000	3,000	
Repairs on machinery per campaign	3,800	
Depreciation of 7 per cent of $250,000 machinery	17,500	
6 per cent interest on $425,000 capital invested	25,500	
Salaries and general expenses		81,200
Wages for labor:		
20 skilled laborers, 100 days and 100 nights, 12 hours per day, or together 4,000 days' work, at $2.50	$10,000	

40 common laborers, 100 days and 100 nights, or together 8,000 days' work, at $1.75	$14,000	
Total wages		$24,000
Running expenses:		
7,500 tons of coal (slack), equal to 15 per cent weight of beets, at $1.50	11,250	
Limestone and coke	12,000	
Oil, etc	1,350	
Reserve materials	3,000	
Linen for filter presses	1,800	
Electric lights furnished by city station	1,200	
Sacks	2,000	
50,000 tons of beets, at average of $4 per ton	200,000	
		232,600
Total salaries, wages, and all expenses		337,800
Product and return for same:		
The general average yield of sugar in America has been 11 per cent of the weight of beets; taking this and the present price of sugar at $92 per ton as a base, the total production from 50,000 tons would be 5,500 tons of granulated sugar, at $92 per ton		506,000
For pulp, at 25 cents per ton, say, per campaign, 7,500		1,877
Margin on seed, 3 cents per pound on 100,000 pounds		3,000
Total returns		510,877
Total expenses		337,800
Net profits		173,077

[NOTE.—Cost of coal, lime, labor, and other materials may be cheaper in your locality than figured in above estimate, and if this is the case the expenses will be less and the cost of producing the sugar cheaper.]

NEW FACTORIES.

Ten or fifteen new factories are now in process of capitalization in different sections of the country, and will probably be ready for working the crop of beets that will be raised in 1898. We are reliably informed that there will be at least two additional factories in New York, one or two in Iowa, one in Michigan, one or two in Indiana, one in Utah, one in Wisconsin, one in Montana, one in Virginia, and one in Oregon. These factories, which will do more to demonstrate the possibilities of the States in which they are to be erected than anything else, will be established under such sure conditions, that they will be the first strong, stout round in the ladder that will carry us to final success in the beet-sugar industry in the United States.

PULP FEEDING.

The following is a report made by Mr. John Reimers, of Grand Island, Nebr., to the special agent, on pulp feeding:

As requested in your favor of the 13th instant to I. R. Alter, I wish to give you my opinion of four years' experience in feeding beet-sugar pulp to cattle.

I consider it a valuable food in connection with grain and other feed, as it is a

great digestive food and appetizer. It has some fattening qualities, but I do not depend on it for that purpose, but mainly to digest the other foods.

When I begin feeding, I use for the first few days from 20 to 25 pounds of pulp per head daily, with hay and little grain or meal mixed with it. Then increase gradually to 40 or 50 pounds per head. I have also tried 80 to 90 pounds per head, but am positive that this is of disadvantage in fattening cattle, as they eat less grain and meal. Too much pulp is inclined to be loosening. Cattle can be put on full feed of grain much quicker with pulp, as it helps to digest the food and lessens the danger of overfeeding or getting the cattle stalled and foundered.

After feeding from ninety to one hundred days, I would advise going back gradually to 20 and 25 pounds of pulp per day and increasing the grain food, which each feeder must judge for himself the amount his cattle can stand.

Cattle eat as much grain per day with the limited amount of pulp as they do without it, but this food in connection produces flesh more rapidly and thereby shortens the feeding season.

I find it better to feed ground feed with pulp rather than whole grain, but the pulp is beneficial with any kind of food. Have found, when feeding pulp with the same amount of roughness and grain that generally is required in the West to fatten cattle, that I would put on an extra gain of from 50 to 75 pounds per head; or I can make the same amount of gain as I obtain in the ordinary way of feeding in three-fourths of the time, and consequently save considerable grain and roughness.

The pulp-fed cattle will sell as readily as any other, as they dress and ship as well, even for export, which I myself have tried. Consider the pulp also a great food for stock cattle, if mixed with roughness, as it is a wholesome food and makes young stock thrive and grow. Cattle will eat poor and damaged roughness, which they otherwise would not touch, if mixed with pulp.

I have fed fresh pulp direct from the factory and also so-called sour pulp after it has been in silo. The pulp will keep in silo for years, but it will shrink some.

The result is virtually the same in feeding either kind of pulp, and I consider them equally good, only that sometimes it takes three or four days before all the cattle learn to eat the sour pulp, while they will all eat fresh pulp readily the first day.

[NOTE.—In talking with others having had extensive experience in feeding pulp to cattle, we secured facts in the main agreeing with the above report. All appear to agree that pulp feeding aids the work of digestion; that the same amount of feed adds more fat and flesh to the animal; that an animal will be prepared for the market six weeks earlier, showing a wonderful economy of time and feed. The gentleman making the report is connected with the Grand Island Live Stock and Commission Company, and has had an extensive experience with the cattle and sheep feeding industry.—C. F. S.]

CRUDE MATERIALS REQUIRED PER TON OF BEETS WORKED.

The following shows the per cent of lime, coke, and coal used in two factories in the United States, based upon the tons of beets worked, and will afford a basis of estimating the amount of these crude materials that will be required by a factory having a stated daily capacity and definite number of days in its working campaign:

Per cent of lime, coke, and coal required to every ton of beets worked.

Factory.	Lime.	Coke.	Coal.
	Per cent.	*Per cent.*	*Per cent.*
First factory	6	2	13
Second factory	5¾	44	11

Sugar Consumption of Leading European Countries and the United States.

The following statement shows the consumption of sugar in the United States per capita from 1867 to 1896, inclusive:

Sugar consumption per capita in the United States.

	Pounds.
1867	28.9
1877	36.2
1887	52.6
1896	62.7

It will be seen that in less than thirty years the amount of sugar consumed in a year per capita in the United States has more than doubled. This is to be attributed to two causes: (1) The people in becoming more prosperous have become more liberal in their daily living; (2) the people are becoming more intelligent, and by investigation better understand the uses of sugar in the arts and sciences and its application to manufacture. We point to the wonderful development of the confectioner's art and the art of making sirups of all kinds for pharmaceutic compounds, soda fountains, etc., during the past thirty years. Sugar is extensively used for curing and flavoring wines and for many other purposes, most of which have been introduced during the period of 1867–1896. Sugar was just beginning to come into use as a food in Queen Elizabeth's time, and the increase in its use has been continuous ever since. This increase in the use of sugar has been going on all over the world. The table following shows the rate of increase in the use of sugar per capita in the leading countries for twenty-three years. The United States leads, as it does in almost all other things, in this increased consumption of sugar.

Rate of increase in consumption of sugar per capita.

Countries.	Per cent in 23 years.	Per cent a year.
France	142	6.18
Germany	157	6.91
Austria	107	4.65
England	90	3.50
United States	278	12.10

If we were to make a classification of countries based upon the intellectual standard of their people and upon the ability of those people to appreciate the daily comforts of life, we would find that our list would represent two things: (1) The countries would stand in the order of the freedom of the people and the liberality of their government; (2) in the order of the amount of sugar consumed per capita in those countries. Under this classification the United States should stand first, but as our country is not old enough to have her position fixed, England takes the first rank. The United States, however, is gaining at the rate

12.1 per cent per year while England's rate is but 3.5 per cent. The following statement shows consumption of sugar per capita in the countries named during 1894–95:

Sugar consumption per capita, 1894–95.

	Pounds.
United States	62.70
England	86.09
France	30.61
Germany	26.78
Austria	19.87
Russia	10.94

The three foregoing tables are taken from a pamphlet by E. W. Hilgard, director of the California Agricultural Experiment Station. Professor Hilgard says:

Two prominent facts are shown by the above tables. The first is that in the United States and in England the consumption of sugar increases in a more rapid ratio than the population, and similar tables show the same to be true of all European countries at least. There is probably a natural limit to the possibility of sugar consumption, even by the American boy and his elders, but it is not likely that that limit will be reached within the next quarter century.

THE BEET-SUGAR INDUSTRY IN GERMANY.

The following table from The Sugar Beet gives in condensed form information concerning the beet industry of Germany.

Condensed data concerning the beet-sugar industry of Germany, 1892–1895.

	1894–95.	1893–94.	1892–93.
Factories working	405	405	401
Number of steam engines	5,324	5,256	5,122
Total horsepower	94,952	87,424	81,596
Total beets worked (tons)	14,526,030	10,644,352	9,811,940
Total area devoted to beets (acres)	1,098,465	987,723	880,000
Average yield of beets per acre (tons)	12.8	10.9	11.7
Raw sugar extracted.			
	Tons.	*Tons.*	*Tons.*
From beets in factories	1,769,331	1,319,006	1,175,137
From molasses (special factories)	61,447	55,165	48,925
From molasses in refineries	4,396	1,427	500
Total raw sugar	1,835,174	1,375,598	1,224,562
Per cent extraction from beets worked	12.17	12.36	11.98
Per cent extraction including the work of molasses	12.64	12.92	12.48
Yield of sugar per acre (pounds)	3,514	3,149	3,276
Weight of beets required to produce 100 lbs. raw sugar (pounds)	822	809	835
Molasses per 100 lbs. beets worked	2.4	2.63	2.54
Total molasses extracted (tons)	347,125	279,757	246,272
Consumption of sugar per capita (pounds)	23.5	20.2	26.78

The above table is presented here because the 1,835,174 tons of raw sugar produced in Germany represents within about 100,000 tons the quantity of all kinds of sugar imported by this country. The details of the sugar industry in Germany are therefore of importance as showing about what would be the condition of the industry in the United States were it established to the extent of producing all the sugar required for home consumption.

Aside from the information set forth in this table, other facts are easily obtained; for instance, the following estimates made from averages of cost of crude materials and labor, prorated on the cost of each for working a ton of beets, are compiled from data secured from the factories in this country:

To install this industry on a scale adequate to providing our entire domestic consumption it would require an investment of capital to the extent of	$200,000,000.00
Farmers would receive annually for beets	60,000,000.00
Coal operators and miners, or other sources of fuel supply, would receive	5,665,151.70
Laborers in the factory, skilled and unskilled, would receive	14,000,000.00
Coke manufacturers would receive	2,500,000.00
There would be paid to quarrymen for limestone, etc	1,743,123.60
The textile manufacturers would receive for filter cloth and bags, chemicals, sugar bags, etc	5,156,000.00
There would go to municipalities to relieve the burden of taxation.	1,452,603.00
Insurance companies would receive	726,301.00

The working of the 14,526,030 tons of beets would result in the production of 5,810,412 tons of pulp.

The following estimates are condensed from an article on "Pulp feeding," by Mr. John Reimers, of Grand Island, Nebr., and provide 60 pounds of pulp per day for milch cows for a year, and 40 pounds per day for cattle during the feeding season; the saving of feed is based upon a reduction of the feeding period by one-fourth:

When this pulp is thoroughly understood and appreciated, it will be worth to the factories for animal food $2,905,206. This pulp would form the principal part of the best feed ration known for milch cows, and would feed for one year 528,219 cows. This amount of pulp could be turned to feeding and fattening cattle, and would be sufficient for feeding ration to prepare for the market 2,421,005 cattle.

It is estimated by extensive, intelligent, and experienced feeders of pulp that a steer can be fattened six weeks earlier on this ration containing grain and pulp [Mr. Reimers puts it: "In three-fourths the time"], so that it can be estimated that the actual saving through the economy of feeding our entire output of pulp would be the whole nutritive ration necessary to fatten 605,251 cattle.

Experience of Successful Growers of Sugar Beets.

The information under this head is compiled for the purpose of giving the results of the experience of successful growers of sugar beets. The numbers preceding the names of those answering the questions in the list correspond to the number preceding the answers.

Answers to questions by sugar-beet growers in Nebraska.

The following is a list of sugar-beet growers in Nebraska, the questions propounded to them, and the answers to the same:

(1) James Seilley, Standard Cattle Company, Ames, Dodge County.
(2) John Duggleby, Standard Cattle Company, Ames, Dodge County.
(3) Gustave Koehler, Grand Island, Hall County.
(4) Gotlieb D. Neunerman (raised beets in Germany), Merrick County.

(5) Fred. Ernstmeyer, Grand Island, Hall County.
(6) John Friend, Grand Island, Hall County.
(7) William Mun and D. A. Finch, Grand Island, Hall County.
(8) Fred. Roby, Grand Island, Hall County.
(9) George C. Humphrey, Doniphan, Hall County.
(10) Edmund Starke, Grand Island, Hall County.
(11) Theo. Sievers, Grand Island, Hall County.
(12) Whitmore Brothers, Valley, Douglas County.
(13) Henry Joehucke, Grand Island, Hall County.
(14) F. H. Brown, Fremont, Dodge County.

Number of acres grown?

(1) 100. (2) 55. (3) 36. (4) 10. (5) 2. (6) 5. (7) 150. (8) 10. (9) 30. (10) 100 to 250. (11) 15. (12) 50. (13) 16. (14) 150.

Usual time for ploughing?

(1) Fall or early spring. (2) Fall. (3) Soon as frost is out of ground. (4) Fall and spring. (5) Fall and spring. (6) Fall and spring. (7) Fall. (8) Fall and spring. (9) Fall and spring. (10) Fall. (11) April. (12) April. (13) Spring. (14) Spring.

For harvesting?

(1) October. (2) October. (3) October. (4) Last September. (5) Last September. (6) October 12 to 20. (7) October to November 1. (8) October to November 15. (9) September 15 to October 30. (10) September 15 to October 15. (11) October 1. (12) October and November. (13) October 15. (14) October 15 begin.

How do you prepare the ground?

(1) Plow; then follow by harrowing, pulverizing, and go over with chain harrow or leveller; then roll and harrow with light harrow.

(2) Pulverize the soil finely and leave surface level.

(3) Plow 12 inches in fall and 6 inches in spring; harrow, then drag to level the ground and plant; as soon as plant is up, use the spider cultivator; then bunch and thin to 6 and 8 inches; hoe once and cultivate twice with Planet, jr.

(4) Plow 3 inches in fall and 9 inches in spring; harrow, roll, and harrow again; then plant.

(5) Same as 4.

(6) Plow 7 inches in fall and 8 inches in spring from April 1 to 15 to kill weeds and loosen the soil; then harrow good; roll the ground and plant an inch.

(7) Extirpating; harrowing; rolling and harrowing.

(8) Plow two or three times in fall, last time 15 to 16 inches; cultivate in the spring to stir the ground; harrow and plant.

(9) Plow 4 to 5 inches in the fall and 10 inches as late as possible in the spring in blocks; to be planted immediately. Follow with slant-tooth harrow as I plant, then float (plank), then plant.

(10) Fall plowing; then cultivate with disk in the spring and harrow thoroughly.

(11) Plow 3 inches in fall and 8 inches in spring, and subsoil 6 inches; harrow and roll or plank.

(12) Best to plow in fall, and either plow or disk harrow early in spring, and then thoroughly harrow the ground.

(13) Plow 3 inches in fall to kill weeds and 10 inches in spring; drag with plank, 3-lapped; then harrow and plank again.

(14) Stubble ground. Plow 9 to 11 inches when weeds started in spring, lap-disked again; then harrow, rolled, and planted.

Explain your mode of cultivation?

(1) First cultivate with knives in cultivator once or as often as may be necessary; then bunch and cultivate; thin and weed; cultivate; cultivate and hoe.

(2) Deep hoeing and deep cultivation.

(3) See (3) under "How do you prepare the ground?"

(4) Cultivate as soon as the plants are up; then bunch and thin; hoe, according to the weeds, two or three times; then cultivate three to four times.

(5) Same as (4).

(6) Bunch and thin 8 to 10 inches apart; cultivate with four-row German cultivator; with knives cultivate once more; cultivate once more with knives and once with plow blades; hoe if weedy. Loosen with beet loosener and pick.

(7) After the beets are just up cultivate with the German cultivator and with knives about 2 inches deep; after that use goose feet.

(8) Cultivate first and then bunch and thin; cultivate and hoe, after which cultivate once more if needed; then pull weeds by hand.

(9) Cultivate with Fremont with drag attachment about the time the beets are up with no cultivator attachments, and harrow again; then bunch and thin; after which cultivate with goose feet. I do not hoe; the harrow answers. I cultivate about six times.

(10) After planting use small harrow; cultivate when up; bunch and thin; hoe twice or three times.

(11) Cultivate with Moline three times; hoe once. We bunch and thin after first cultivation.

(12) Hand hoe and thin; then cultivate with small, fine one-horse cultivator made for the purpose.

(13) Cultivate early with Moline before the beets are up, if necessary, for weeds; cultivate three or four times to keep weeds down and soil open; hoe twice; also thin and bunch.

(14) As soon as plants show I go over with a wheel hoe operated by two men; then use Fremont horse cultivator; after which thin and bunch; then cultivate twice, and afterwards cut out weeds.

Describe your soil?

(1) Sandy loam, black loam, and gumbo.

(2) Gumbo.

(3) Sandy loam with gravel and clay subsoil.

(4) Very sandy; sandy subsoil.

(5) The same as (4).

(6) Sandy loam; sandy subsoil, with some clay.

(7) Sandy loam; clay subsoil.

(8) Sandy loam; sometimes clay; sometimes sandy followed by hardpan under that.

(9) Black sandy loam; yellow clay subsoil.

(10) Sandy loam.

(11) Sandy loam and clay subsoil.

(12) Rich black sandy loam, with free sandy subsoil.

(13) Sandy loam, with sand and sometimes clay subsoil.

(14) Rich black loam. Would prefer a little sand.

What are the requirements of beets for moisture?

(1) Beets seem to be able to stand dry weather after they start to grow; they also do well with lots of rain.

(2) They will stand wet or dry weather.

(3) Require much less moisture; taproot will go down sometimes 8 to 10 feet.

(4) Can stand more rain and much less than any other crop.

(5) Same as (4).

(6) Will thrive with one-half less moisture than is required by other crops and will stand more until time of ripening.

(7) If ground is in good condition in the spring, will need only one rain to sprout; should have a good and damp August.

(8) Need less moisture and can stand more than other crops.

(9) They do not require as much moisture as other crops.

(10) Can stand more or less moisture than any other crop.
(11) Require much less than other crops.
(12) Damp, fine seed bed with frequent showers while growing.
(13) Require less moisture than other crops, and can stand more.
(14) Not as much as corn, as they grow deeper in the ground.

What are your estimates per acre for cost of raising and marketing beets?

(1) $25 per acre and $13 for marketing without freight.
(2) The same as (1).
(3) $20. Improved machinery and cheaper labor where available make these figures much less. Harvesting will be about $9 additional.
(4) $15 to $16, and $9 to $10 for harvesting.
(5) The same as (4).
(6) $15; which includes bunching, thinning, hoeing two times, and plowing three times. Harvesting costs me $6 per acre; 4 miles from factory.
(7) About $36 per acre. This includes harvesting.
(8) $16 per acre; harvesting and marketing $14 more.
(9) $25; harvesting and marketing will be $8 more. My beets must be delivered 5 miles by wagon and then 12 miles by railroad.
(10) $16 to $17 for raising the beets, and about the same for harvesting.
(11) I do not know.
(12) Generally about $30 per acre, and $10 for marketing and harvesting.
(13) $20 to $25, and about $4 marketing the beets.
(14) $20 to raise the beets, and $6 per acre when harvested without siloing.

How many tons do you average per acre?

(1) 18 tons. (2) 17 tons. (3) 12 tons. (4) 10 to 12 tons. (5) The same as (4). (6) 14 tons. (7) About 11 tons. (8) 16 to 18 tons. (9) 10 tons. (10) 10 to 15 tons. (11) 13 to 15 tons. (12) 15 tons. (13) 12 tons. (14) 10 to 15 tons.

What is the average sugar quality of your beets?

(1) 14 per cent sugar content, 81.5 per cent purity. (2) 13 per cent. (3) 16 per cent. (4) 14 per cent sugar, 80 per cent purity. (5) The same as (4). (6) 14 per cent. (7) Last year 14.2 per cent. (8) 14 per cent. (9) 14.8 per cent sugar, 82 per cent purity. (10) 15.8 per cent sugar, 85 per cent purity. (11) Good test. (12) 12 per cent sugar, 80 per cent purity. (13) Do not know. (14) 12 to 15 per cent.

What do you recommend in the way of equipment, horses, and implements?

(1) For small farmer would recommend stirring plow, corn cultivator to go both ways and to harrow both ways; Moline's seeder, roller, and small harrow cultivator. F. M. Wallace, of Fremont, has the best cultivator I know, and A1 puller can be obtained at Fremont foundry.

(2) Mules. Any implements can be used that will leave the ground level, loosened down deep, and thoroughly pulverized.

(3) Stirring plow, beet seeder, harrow, drag, two horses, Planet, jr. cultivator, and hoes. My work was largely experimental in starting the industry. I came from the beet-sugar districts of Germany.

(4) Stirring plow, roller, cultivator (Moline), harrow, and hoes.
(5) The same as (4).
(6) Stirring plow, harrow, cultivator, seeder, hoes, beet puller, roller. I find that planking pulverizes the ground but does not make it compact.
(7) Use, if possible, mules; Jewell beet drill, cultivator.
(8) Stirring plow, two to four horses, a stirring-plow cultivator (Fremont), harrow (no roller or plank), hoes.
(9) A good team of three horses, stirring plow, float, harrow, a good cultivator like the Fremont. I think a cultivator should take only two rows, on account of the unevenness of the ground.
(10) Two horses, plow, cultivator, harrow, seeder, beet puller.
(11) Stirring plow and subsoiler, Moline cultivator, roller, harvester, hoes.

(12) Use same plows, teams, men, etc., as for other farm work, adding fine harrow, cultivators, hoes, hand weeders, etc.

(13) Moline cultivator, good stirring plow, small strong horse or mule, good harrow, three horses for stirring-plow work, plank harrow.

(14) One combined seeder and cultivator, plow and harrow.

How many acres with good equipment can one man tend?

(1) Ten acres by himself.

(2) Seven acres, if alone.

(3) After the thinning and bunching and help to hoe once, one man cultivated 35 acres.

(4) Five acres, alone.

(5) Five acres, alone.

(6) One man and two boys can thin and bunch 10 acres in ten days, then one man can tend 10 acres alone.

(7) Five acres.

(8) Ten acres, if the man hires the bunching and thinning, which will cost $70.

(9) Thirty acres, by paying $1.50 per acre for bunching and thinning. This is my experience. My ground is quite free from weeds, however.

(10) Five acres, working alone.

(11) I do not know.

(12) 2 acres.

(13) 10 acres, working alone.

(14) One cultivator will tend 40 acres, but will have to have extra help in thinning and weeding.

What are the obstacles you encounter, including diseases, insects, etc?

(1) Have had no disease to contend with. Have had trouble with black cutworms and white bugs usually found on cockleburs, and with another bug that flies in swarms; do not know name, but they only affect the plant in spots, which usually grow again.

(2) Trouble with nothing besides cut and grub worms.

(3) Have had no difficulties of this kind.

(4) The same as (3).

(5) The same as (3).

(6) Sometimes small red ants are encountered when the plants first come up.

(7) Cold and wet Mays are injurious for sprouting and heavy winds are apt to hurt the plants just after they come up.

(8) Nothing.

(9) High winds, which drive the sand and cause it to cut off the plants. We have trouble with hail, but it does not injure beets as much as other crops. The leaves of my crop were all cut off twice last year, but they grew out again, but the hail did not hurt the roots.

(10) None whatever so far.

(11) Nothing.

(12) Encounter about the same difficulties as in growing a garden. Sometimes bugs eat the plants.

(13) Poor seed. Too much wet or dry weather. In 1892 small striped worm, about half the size of cutworm, destroyed all leaves.

(14) Insects do but little damage. The wind does more damage than anything else.

What are the staple products of your locality?

(1) Corn, oats, and wheat; principally wheat.

(2) Corn and oats.

(3) Corn, oats, barley, wheat, alfalfa.

(4) Corn, oats, rye, wheat, and barley.

(5) The same as (4).

(6) Rye, oats, corn, wheat, and vegetables.
(7) Corn, oats, and rye.
(8) Corn, oats, rye, wheat, potatoes, etc.
(9) Corn, oats, wheat, rye.
(10) Corn, wheat, rye, oats, alfalfa.
(11) Corn, oats, rye, wheat.
(12) Corn, hay, oats, potatoes, onions, beets.
(13) Corn, oats, rye, and some wheat.
(14) Corn, wheat, oats, wild and domestic grasses.

How do sugar beets compare with the above crops for profit?

(1) If properly handled the beets are much more profitable.
(2) Better.
(3) The beets pay a man 100 per cent better for the same effort and capital.
(4) One acre of sugar beets will pay better than 10 acres of corn or other crops mentioned.
(5) The same as (4).
(6) Beets give a much higher profit.
(7) No answer.
(8) Much better.
(9) Beets pay better.
(10) Five acres of beets pay in comparison better than 30 acres of other products.
(11) They afford considerably more profit.
(12) The net profit, as a rule, in raising sugar beets is no better than in raising the other crops mentioned.
(13) Pay better than any of the staple crops mentioned.
(14) When the beets come up to a good test they pay better than other crops mentioned.

How long have you been raising sugar beets?

(1) Five years. (2) Five years. (3) Three years. (4) Four years in Germany and six years in Nebraska. (5) Four years. (6) Two years. (7) Two years. (8) Seven years. (9) Two years. (10) Four years. (11) Six years. (12) Four years. (13) Six years. (14) Three years.

What fertilizer do you use?

(1) Barnyard manure. (2) None. (3) Barnyard manure. (4) Barnyard manure. (5) Barnyard manure. (6) Stable manure. (7) No answer. (8) Barnyard manure. (9) Barnyard manure. (10) Barnyard manure. (11) None. (12) Manure. (13) Barnyard manure. (14) None.

How do you apply fertilizer?

(1) Haul it to the field in the fall; scatter it lightly and evenly over the ground, and plow it under as soon as possible.
(2) Do not apply fertilizers.
(3) Well-rotted manure gives good results.
(4) For fall plowing apply 10 to 12 loads per acre.
(5) For fall plowing apply 10 to 12 loads per acre.
(6) Apply thin coat, well rotted, and get good results.
(7) Scatter it broadcast immediately after plowing and before harrowing.
(8) Apply it thickly and well rotted the year before planting.
(9) Applied well rotted increases the growth.
(10) Apply it to the field before plowing.
(11) Do not use fertilizers.
(12) Plow in well the year before the plants are to be planted.
(13) Applied well rotted gives good results.
(14) Do not apply fertilizers.

How deep should ground be plowed?

(1) Ten to 12 inches.

(2) In the fall as deep as possible and 8 inches in the spring.
(3) Plow 12 inches in the fall and cultivate in the spring.
(4) In the fall 3 inches and in the spring 10 inches.
(5) In the fall 3 inches and in the spring 10 inches.
(6) Plow 7 inches in the fall and 10 inches in the spring.
(7) It should be plowed about 10 inches.
(8) Shallow plow in the fall twice and then 15 to 16 inches.
(9) Plow 4 inches in the fall and 10 inches in the spring.
(10) The ground should be plowed from 12 to 15 inches.
(12) Plow 12 inches.
(13) The ground should be plowed 10 inches.
(14) Plow 9 to 11 inches.

How deep should seed be planted?

(1) The depth of planting should be governed by condition of the land.
(2) Plant seeds 2 inches.
(3) Plant 1 inch or 8 times the diameter of the seed.
(4) Plant seed about one-half inch.
(5) Plant seed about one-half inch.
(6) Plant 1 inch.
(7) Plant from one-quarter to one-half inch.
(8) One inch, but if soil is dry plant deeper.
(9) Seed should be planted from one-half to three-quarters inch.
(10) Should be planted one-half inch and no deeper.
(11) Plant 1 inch deep.
(12) Plant 1 inch or less.
(13) If soil is moist plant three-quarters inch, but if dry 1 inch.
(14) Seeds should be planted from one-half to three-quarters inch.

What do you think about ridging the rows?

(1) Prefer smooth cultivation, but have had very good success with ridging.
(2) I do not like ridging the rows.
(3) I found it a good plan in Nebraska to plant level and ridge by cultivation.
(4) Never have done anything of this kind.
(5) Never have done anything of this kind.
(6) We can cultivate the beets in this way.
(7) I think it is a mistake to ridge any beet rows.
(8) I do not like ridging the rows.
(9) I keep the rows as flat as possible; ridging has a tendency to raise the beets out of the ground and the rain washes away the dirt.
(10) I never ridge my rows and do not believe it is a proper thing to do.
(12) Do not ridge the rows, but mellow the ground deeper instead.
(13) Do not ridge the rows.
(14) Do not ridge; cultivate 9 inches deep so the beets can grow down.

How do you silo your beets?

(1) Take about thirty-five or forty rows of beets; begin in the center; leaving a place for the silos, I throw the beets in piles and top under bottom leaves. Throw in piles as you top, cover with 6 inches of earth, leaving air holes on tops of piles; later cover with hay, then cover with more earth.

(2) Put the beets in piles of 2 tons and cover with dirt 6 inches deep, leaving air holes.

(3) I never keep my beets after harvesting; the factory being near they are hauled there at once.

(4) Put the beets in a ditch 1 foot deep and 4 feet wide; after these piles are 3 feet high cover with 6 inches of dirt and then with horse manure when very cold. Place ventilators along the top of the ridge, made with straw.

(5) Use the same process as (4).

(6) Take off surface of the ground 5 to 12 inches and pile the beets until 2½ to 3

feet high, then cover with 6 inches of dirt. Will keep in this way until Christmas. If it gets too cold cover with straw or manure.

(7) Put about 5 tons in silo and cover the same with 8 inches to 1½ feet of dirt.

(8) In long ridges, 4 to 5 feet wide and 3 feet high; cover with 6 inches of dirt, and later cover with hay and coarse manure.

(9) Short ricks of 1½ tons, 3 feet wide at bottom and 3 feet high; cover with 4 inches of dirt; about middle of November cover with coarse straw 4 to 6 inches. In this way I had beets that kept all winter.

(10) Place the beets on top of the ground in rows 5 feet wide and 3½ feet high and make length as may be convenient. Cover with dirt 6 inches.

(11) I pile the beets on the ground in ricks 10 to 30 feet long, 5 feet wide at bottom and 3 feet high. I cover the ricks with straw and 4 to 5 inches of dirt.

(12) I dig a trench with a road scraper, into which I throw the beets and cover with hay or straw and dirt.

(13) I pile the beets on the ground in rows of convenient length, 6 feet wide at the base and 3 to 3½ feet high, and cover with 6 inches of dirt, leaving ventilator holes every 8 or 10 feet. The beets in this way will keep until Christmas. If necessary cover with coarse manure or straw in the coldest weather.

(14) Put them in silos 20 to 50 feet long.

How many times do you hoe after thinning?

(1) Twice. (2) Twice. (3) Hoe once. (4) Once. (5) Once. (6) Twice. (7) Hoe at least twice. (8) Once. (9) Do not hoe after thinning. (10) Hoe two or three times. (11) Hoe twice. (12) Three times. (13) Hoe twice. (14) Once.

Does hoeing increase the yield?

(1) Seldom. (2) Yes. (3) No answer. (4) No answer. (5) No answer. (6) No answer. (7) Yes. (8) No answer. (9) No answer. (10) Yes. (11) Yes, cultivation also increases yield. (12) Yes. (13) Yes. (14) Not if cultivation is deep.

What is your experience?

(1) If land is in good, clean condition and properly cultivated, a good deal of hoeing can be dispensed with.

(2) I have always hoed twice or three times.

(3) The greater the cultivation the better the results.

(4) I think one hoeing is enough.

(5) I think one hoeing is enough.

(6) Working the land often will produce good results.

(7) No answer.

(8) Each hoeing will make two tons to the acre.

(9) Keep the field clean and loose by cultivation. Hoe if the weeds get a start. I was weigh-master at Grand Island for two campaigns, 1895 and 1896, under the appointment of secretary of state on account of bounty. The factory rejected seventy car loads of beets during my first year, but afterwards accepted the beets and worked them up, paying $2.50 per ton. During my second year no beets were rejected. I think the first rejection was due to poor seed and bad, dry year. Very few beets tested 12 and 80 per cent in 1895.

(10) Frequent hoeing will increase the yield of beets considerably.

(11) Cultivation increases the yield.

(12) The principal reasons that growing sugar beets has not been more profitable are high-priced labor (regular men getting $1.25 per day); high freight ($1 per ton) to factory. We must raise at less expense and have a factory nearer home.

(13) They can not be worked too much after the 4th of July, as will become too large.

(14) No answer.

How far apart do you plant the rows?

(1) 18 inches apart. (2) 18 inches apart. (3) 18 inches apart. (4) 18 inches apart. (5) 18 inches apart. (6) 18 inches apart. (7) 14 inches apart. (8) 18 to 20

inches apart. (9) 18 inches apart. (10) 14 inches apart. (11) 18 inches apart. (12) 17 inches apart. (13) 18 inches apart. (14) 18 inches apart.

How far apart do you thin out the beets? How much seed do you use per acre?

(1) On very rich land, 8 inches; poorer land, 9 or 10 inches.

(2) 8 to 9 inches.

(3) 6 to 8 inches. I use 20 pounds seed to the acre.

(4) 8 inches. We use 15 pounds seed to the acre. With use of hand machine can get along with 8 pounds seed.

(5) 8 inches.

(6) 8 inches. I use 20 pounds seed to the acre; more than necessary if seed is good.

(7) 8 inches.

(8) 5 to 8 inches. Twenty pounds seed should be planted to the acre.

(9) I average 6 inches. I plant 18 pounds seed to the acre.

(10) 8 to 10 inches.

(11) 6 inches; plant 18 to 20 pounds seed to the acre.

(12) 6 to 8 inches.

(13) 8 to 10 inches. I plant 20 pounds to the acre.

(14) 8 to 10 inches.

ANSWERS TO QUESTIONS BY FACTORY OFFICIALS AND FARMERS IN CALIFORNIA AND NEW MEXICO.

Following is a list of sugar-beet growers in California and New Mexico, the questions propounded to them, and the answers to the same:

(1) Agriculturists at Alvarado factory, Alvarado, Alameda County, Cal.

(2) S. D. Galliger (one of the best farmers) Watsonville, Santa Cruz County, Cal.

(3) S. Jenson (one of the best farmers) Watsonville, Santa Cruz County, Cal.

(4) W. C. Waters, manager Watsonville factory, Watsonville, Santa Cruz County, Cal.

(5) E. H. Dyer, builder and operator of five factories in the United States, Alvarado, Alameda County, Cal.

(6) L. Hache, agriculturist, Chino factory, Chino, Cal.

(7) J. L. Elam, farm superintendent, Alamitos factory, Los Alamitos, Cal.

(8) R. C. Nisbet, farm superintendent of factory, Eddy, Eddy County, N. Mex.

Number of acres grown?

(1) 4,900 acres, by the farmers for the factory. (2) 60. (3) 30. (4) No answer. (5) No answer. (6) No answer. (7) No answer. (8) 2,100.

What is the usual time for plowing and harvesting?

(1) Grain ground in fall after first rain; other ground in the spring. Harvesting begins middle of August and lasts until November.

(2) Plow in winter; harvest from August to December.

(3) Plow Christmas time; harvest between middle of August and December.

(4) Plow in fall and harvest August to January.

(5) Plow middle of April and in lowlands June 1; harvest from September 1 to last November.

(6) Plow deep as possible before rain and harvest from July to November 15.

(7) Plow as early as possible and harvest from July 1 to end of campaign.

(8) Plow fall and winter. Harvest 150 to 160 days after planting in this climate.

How do you prepare the ground?

(1) Plow stiff land 16 inches and sandy land 10 to 12 inches; subsoil; pulverize very thoroughly, and roll before sowing; in dry weather roll after sowing.

(2) Plow 12 inches; cultivate or plow again 8 to 10 inches; harrow fine and thin; hand hoe once.

(3) Plow 10 to 12 inches. The harvesting of beet crop plows the ground for the next crop, which will be barley or potatoes.

(4) Plow in fall; cultivate four to five times before planting and gain a little depth each year; harrow down fine and let it rest about five days for moisture line to establish itself.

(5) Plow 12 to 14 inches in spring; harrow to very fine and pulverized condition; roll after planting.

(6) Plow ground as deep as possible, before rain if possible, 12 to 14 inches, using 4 to 6 horse single plows; harrow, roll, and pulverize; cultivate during the winter to kill the weeds; cultivate deep in the spring and roll and plant; thin when three-quarters of the plants have four leaves, then cultivate with goose-feet cultivator three or four times; hand hoe once to clean out weeds. Plant February 15 to June 1.

(7) Plow as early as possible; then plow 12 inches across the second time; harrow the ground, and in the spring, after the rains, cultivate or harrow the land well; plant, thin out, and cultivate with Moline or kindred four-row plow several times, and hand hoe. It pays to hand hoe. The soil runs down about 6 feet and then we have a quicksand subsoil; subirrigation comes down into this sand strata and capillary attraction brings it up in the soil. We must keep a dust mulch to stop evaporation. We plant from February to March 30.

(8) Plow 12 to 14 inches in fall; cultivate in spring or disk, then harrow and plant the same day; previously (say four days) to this we have irrigated; harrow on the level.

Explain your mode of cultivation and describe your soil.

(1) We cultivate with one-row cultivator, on account of unevenness of ground, about 7 inches, simply loosening and turning up the soil twice; hoe twice. The soil is sandy, with little loam, then sandy loam and disintegrated soil.

(2) Hire Japanese at 50 cents per ton to thin, hand hoe, and keep out weeds; hand hoe once; horse hoe once; black sand loam.

(3) Thin out as early as possible, or about the time 4 leaves are out; early thinning is important; then with horse hoe, single-row hoe once; cut out weeds if any last; previous to horse hoeing hand hoe once; prepare land by cultivating once or twice in spring before planting; black loam soil.

(4) Thin and weed in the rows by hand; push hoeing once single row; one to three horse cultivations, according to the looseness of sand, down 3 to 6 inches. The soil is (1) sandy sediment, (2) clay sediment, (3) adobe. The latter is good as any, but requires more labor.

(5) Cultivate with Planet, Jr., once; hand hoe once; thin and bunch early so as not to disturb the plants, the earlier the better, or as soon as you can tell beets from weeds. The soil is sandy made land from wash of mountains; sandy adobe which becomes hard.

(6) Answered as to cultivation in reply to previous question. Mostly sandy loam, 3 to 8 feet; subsoil, white clay; sometimes layers of coarse sand.

(7) Answered in reply to previous question. Soil, sandy loam; subsoil, clay with sand strata.

(8) To insure thorough stand, follow planting with water furrowing and water; cultivate three or four times; hoe once; irrigate three to four times. The rows alternate 14 to 26 inches apart, with water furrow in wide row. The soil is a very fine dust sediment 3 to 20 feet deep, followed by a lime solid hardpan.

What are the requirements of sugar beets for moisture?

(1) Plenty at time of germination. We want no moisture after June. Light showers and heavy rains bake the soil and not much is required. Got none this year.

(2) Heavy winter and March rains; light showers for summer.

(3) My beets had no rain after planting; should have showers before planting and heavy rains in winter and spring.

(4) Want three or four rains in November, none in December, five in January, three to four in February, and spring showers to 24th May, and this will do the business. Beets do best in dry years.

(5) If we plant on fresh ground, the seeds germinate, dry out, and die. We wait until the top dries and moisture comes up from below. We need April rains, and then the reserve the soil carries will mature the crop with slight showers.

(6) We get rain from December to March and showers in April.

(7) The moisture comes up in November to the surface without rain; in low places it stands in pools. The days are short, the nights are cool and winds less in fall, consequently evaporation is reduced.

(8) Four or five irrigations, with one for cultivating the seed bed in the spring. Irrigate after seeding once about thinning time and the other two when the beets call for it.

What are your estimates per acre for cost of raising and marketing beets? What are the rent values?

(1) $22 to $30 per acre rent; $15 to $20 per acre cash. The cost of raising the beets includes the marketing.

(2) $19.50 per acre; rent $10. I pay Japanese 50 cents per ton and deliver the beets to the factory at $1.50 cost to me.

(3) $36 per acre; rent $8 per acre. I get about $56 per acre. The cost per acre includes marketing.

(4) $28 per acre, delivered to the factory; rent $8 to $20. We have 10,000 acres that average $10.50. Sugar beets double the price of rents.

(5) $30 and $35, raised and delivered.

(6) $20 to $25 per acre; rent one-fifth to one-quarter of crop. We average $4.25 per ton for beets.

(7) $25 per acre; rent one-quarter crop. Beets average 9 tons, at $4.50 per ton, making rent about $10. Will make more later.

(8) I had 30 acres and paid for everything, and it cost me $25 per acre to put the beets on the cars. With farmers the amount is usually about this figure.

How many tons do you average per acre, and what is the average sugar quality of your beets?

(1) 11 to 14 tons per acre; 10½ per cent white sugar quality.

(2) 15 tons; do not know the sugar quality.

(3) 14 tons per acre; I do not know the sugar quality.

(4) 12 tons sure; 18 per cent sugar quality; 80 purity.

(5) 15 tons per acre; 14 to 15 per cent sugar quality; 80 to 83 purity.

(6) Average 12 to 15 tons; 15 to 16 per cent sugar quality; purity 80.

(7) This year 9 tons; 16.5 sugar quality; purity 84.

(8) I had 9 tons per acre. The returns from the factory from general sources showed about 8 tons. Last year had 16⅔ per cent for sugar quality and purity 86 for entire campaign.

What do you recommend in the way of requirement, horses, and implements?

(1) No answer.

(2) Double gang heavy 5-foot cut cultivator; hand hoes; 5 or 6 horses (heavy); beet seeder, beet harvester, and beet cultivator.

(3) Gang plow (this takes from 5 to 6 horses); hoe cultivator which takes 5 feet and for preparing land 12 inches deep will take 5 to 7 horses; hand hoe.

(4) Hand wheel hoe; horse 4-row cultivator; two 12-inch Stockton gangs; har rows; horses.

(5) Single-man wheel hoes; horse single-row hoes; deep roller.

(6) No answer.

(7) No answer.

(8) Four good horses; stirring plow; cultivator; disk; harrow.

How many acres, with good equipment, can one man tend?

(1) No answer.

(2) With 50 cents per ton for Japanese labor he can tend 40 acres.

(3) 40 to 50 acres with help to do the thinning and hoeing.

(4) 10 acres.

(5) I do not know.

(6) No answer.

(7) No answer.

(8) 25 to 30 acres.

What are obstacles you encounter, including diseases, insects, etc.?

(1) Worms and extreme dry weather.

(2) Nothing.

(3) Some bugs, some cutworms, and dry weather.

(4) Black beetles do some damage, but seldom cutworms; a small black fly does some damage when the beet is ripening, but not serious.

(5) Dry or wet weather occasionally; sometimes cutworms cause damage.

(6) No answer.

(7) No answer.

(8) We had a small beetle that produced a worm that attacked the beets, completely destroying some. It was similar to the Colorado beetle. Then, beets suffer seriously here from a rot that attacks the taproot, which rots and completely destroys the root as it works up the beet, which in time dies. We have suffered seriously from this disease at this time.

How often do you rotate, and with what?

(1) Plant corn one year, potatoes one year, and then beets.

(2) Barley or wheat; potatoes; beets.

(3) Beets; grain; potatoes; some two years beets.

(4) Every year. Beets; barley; potatoes.

(5) Three crops. Beets; then barley; then beets.

(6) We do not grow much of anything but beets; rest ground when necessary.

(7) No answer.

(8) We have raised beets but one year; we can grow alfalfa and corn, and we will probably rotate with these.

Would you treat land for beets that had grown beets the year before, and what are the staple crops of your locality?

(1) You can grow beets for two years in succession, possibly; it dries the soil too much to continue longer. Staple products here are fruit, potatoes, corn, onions; ordinarily beets pay about as well.

(2) Our staple crops are barley, potatoes, wheat, and beets. Beets will pay as well on the average as wheat. This year I made $40 per acre clear above all expenses but rent; I own the land.

(3) Barley, potatoes, wheat, and fruit. Beets are much the best crop; they compare favorably with wheat this year.

(4) Never follow with beets the next year; our staple products are barley, potatoes, beans.

(5) Staple products are barley, wheat, corn, fruit, potatoes, and gardening. Beets are much the best crop.

(6) Wheat, barley, and beans are grown here. We do not raise much of anything but beets, as they pay best. We do not rotate, but rest the soil when necessary. We raise 15 to 20 sacks barley to an acre.

(7) We rotate with barley or corn. We grow besides beets, potatoes, corn, some wheat, and fruit.

(8) Our staple products are alfalfa, corn, beets.

[NOTE.—The comparisons with wheat were in September, when it was selling for $1 per bushel.—C. F. S.]

How long have you been raising sugar beets? What fertilizer do you use, and how do you apply it?

(1) Eight years. (No answer as to fertilizer.)
(2) Five years. (No answer as to fertilizer.)
(3) Five years. (No answer as to fertilizer,)
(4) No answer.
(5) Several years. Do not use fertilizer.
(6) No answer.
(7) No answer.
(8) One year. Do not use fertilizer.

When and how deep should ground be plowed, and how deep should seed be planted?

(1) No answer as to ground. Seed should be planted one-half inch to 2 inches, depending on moisture; if dry, plant deep.

(2) Plow fall and winter 12 to 14 inches. Plant seed one half to three-fourths inches if dry.

(3) Plow 12 inches at Christmas time, and cultivate once or twice in the spring. Plant seed 2 to 4 inches when ground is dry.

(4) Plow in fall and cultivate in spring; plow 8 inches to start with. Plant seed an inch, and deeper if the moisture line is deep.

(5) Plow 12 to 14 inches in the spring. We have no frost, and the ground packs with fall plowing. Plant seed one-half inch if dry.

(6) No answer.
(7) No answer.

(8) Plow 12 to 14 inches in fall and winter. Plant seed 1 to 1½ inches.

What do you think about ridging the rows, and do you silo your beets?

(1) Ridging will not do here. It is too dry. Do not silo.

(2) Flat farming prevails here. Do not silo.

(4) All flat. Generally plant the other way and put the rows at right angle with the wind, which is usually from the west, so that the sand will not dry and cut the beets; thin as soon as possible or just as soon as plant has two leaves. The cost for four leaves will be $4 more than for two leaves for thinning.

(3) We farm flat; in fact, would rather put in trenches.

(5) Do not ridge, but make them as level as possible. Do not silo.

(6) No answer.
(7) No answer.

(8) Do not approve ridging. I plant flat and furrow in the wide rows. Do not silo, but keep them in the ground.

How do you top beets?

(1) One at a time with a knife.
(2) With single stroke of a large knife.
(3) With a single stroke of large knife and throw tops in piles.
(4) By hand with one stroke of 12-inch knife and pile on end in rows.
(5) Top by hand with one stroke of large knife in the field; cut all above ground.
(6) No answer.
(7) No answer.
(8) With one stroke of a large knife.

How many times do you hoe after thinning, and does frequent hoeing increase the yield?

(1) Once before and once after thinning; frequent hoeing increases yield very much.

(2) Once by hand and once by horse hoe; cultivate mostly before planting.

(3) Once with wheel hoe and once with hand hoe.

(4) I seldom hoe after thinning, except to kill weeds.

(5) Once; we have no trouble with weeds after first hoeing; I think twice is enough.

(6) No answer.

(7) No answer.
(8) Once; does not increase the yield much.

How far apart do you plant the rows, and how far do you thin out?

(1) 18 inches apart; on ordinary land I think 6 to 10 inches, on good land 6 inches.
(2) 20 inches apart; thin 6 inches.
(3) 20 inches apart; thin 8 to 10 inches.
(4) 20 inches apart; thin 3 inches to 2 feet, depending on soil; if very light and sandy thin 2 feet.
(5) 15 inches apart, and sometimes 18 inches; thin 4 to 5 inches.
(6) No answer.
(7) 18 inches apart; thin 6 to 8 inches in rows.
(8) Alternate 14 and 26 inches apart; thin 8 inches.

How much seed do you plant per acre, and what varieties do you use? Which do you prefer?

(1) 15 pounds per acre; Kleinwanzlebener and Vilmorin seed. Prefer Kleinwanzlebener for stiff land and Vilmorin for soft and loose land.
(2) 10 pounds per acre; Kleinwanzlebener.
(3) 12 pounds per acre; use Kleinwanzlebener seed.
(4) 2½ pounds to 10 pounds, according to width of rows; use Kleinwanzlebener, which I prefer.
(5) 15 pounds per acre. I use Kleinwanzlebener. I prefer Imperial Rose (Verbersetta Rosa). The latter while not a high sugar beet does better.
(6) No answer.
(7) No answer.
(8) Use original Kleinwanzlebener and the Horning strain of the same; prefer the Horning.

Are the tops good stock feed?

(1) Yes; but better for fertilizer.
(2) Yes; but better for fertilizer.
(3) Yes; we sell it for 25 cents per load.
(4) Yes; but we do not allow the tops to be removed, as they are used as a fertilizer.
(5) Yes; but it pays better to use them as a fertilizer.
(6) No answer.
(7) No answer.
(8) I think not.

What do you think of sugar beets for feed?

(1) I think they make good feed for cattle, sheep, and hogs.
(2) Make a good feed.
(3) Do not know.
(4) Make a first-class feed.
(5) They make a first-class feed. I once fattened 1,000 hogs by steaming beets. Make a good horse feed and are good for milk.
(6) No answer.
(7) No answer.
(8) Do not think much of them for this purpose.

What do you think of pulp for feed?

(1) First-class for milk and feed of cattle, sheep, and hogs.
(2) Makes a fine feed for all kinds of stock.
(3) I have not tried it.
(4) The pulp is first-class for fattening.
(5) Pulp is good for feed for dairying and for ration for fattening animals.
(6) No answer.
(7) No answer.
(8) I have not experimented with it.

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